ELECTRICAL REVIEW

FRIDAY
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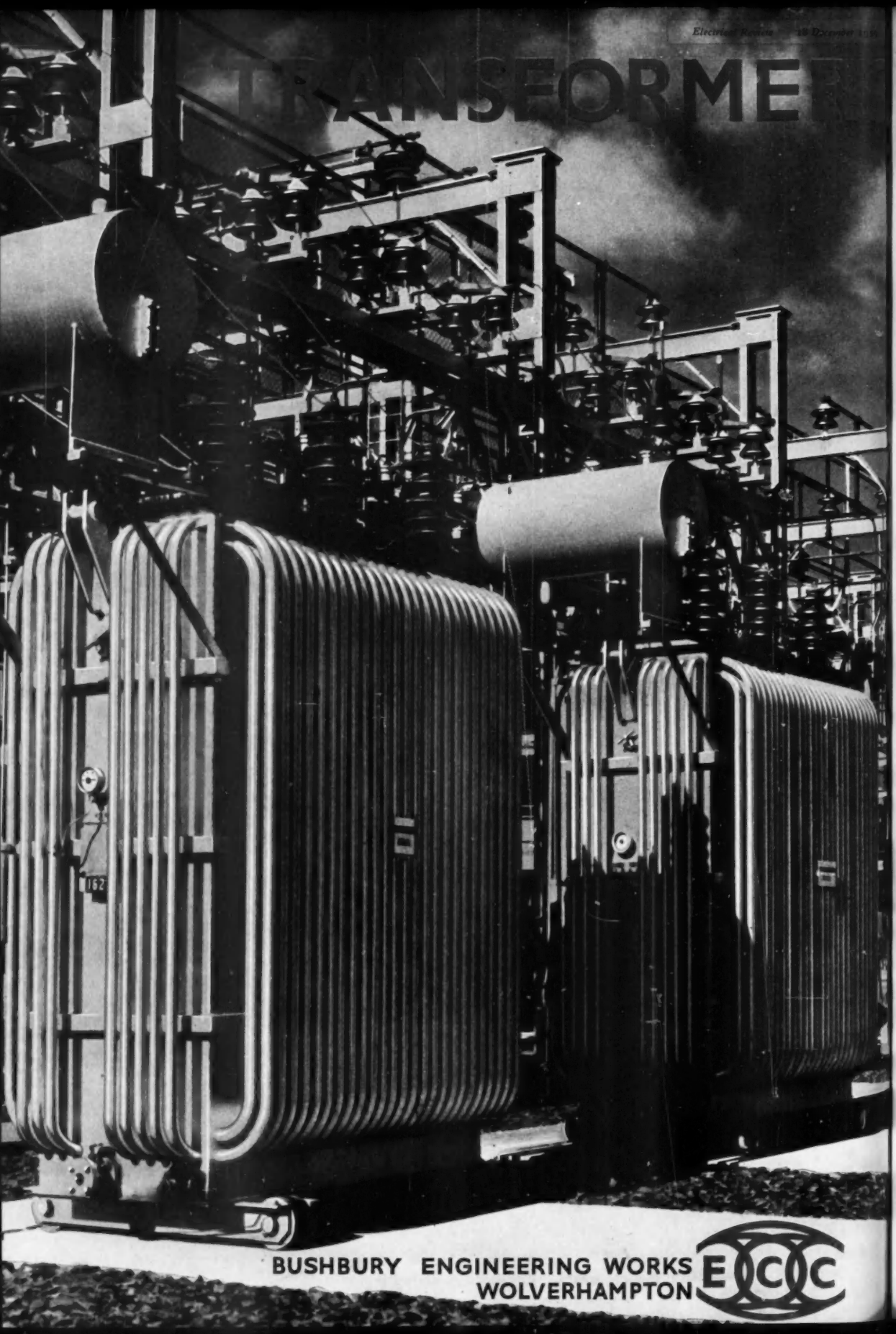

BUSHBURY ENGINEERING WORKS
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ELECTRICAL REVIEW

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Progress in Switchgear Testing

THE steady growth of the high voltage electricity supply network in this country, which led to the initiation of the national grid system in 1926, focused attention on the vital and urgent need for adequate facilities for the short circuit testing and certification of British switchgear and other apparatus. Efforts were made, mainly by the late Mr. H. W. Clothier and the late Mr. E. B. Wedmore, then director of the Electrical Research Association, to institute a national testing station, but the necessary money could not be found and eventually various electrical manufacturers decided to build testing stations to cater for their own requirements and also those of their customers. The first short-circuit testing station was set up by Mr. Clothier in 1929 for A. Reyrolle & Co., Ltd., at Hebburn-on-Tyne.

By 1938, four such stations were in operation and, at the same time, there was a great deal of activity in connection with research and development work on switchgear. It soon became evident that a fair and uniform comparison of testing results could not be achieved unless there was some central body for co-ordinating tests and testing procedures at the various privately owned stations and to issue performance reports and certificates of rating that would be nationally recognised.

Thus, the Association of Short-Circuit Testing Authorities was formed and last week it celebrated its 21st anniversary. Now there are eleven member companies operating eight short-circuit testing stations, seven of which are specially equipped for testing large circuit-breakers, reactors, transformers, and fuses. The eighth station tests fuses only. The affairs of the Association are under the control of a Council and a Management Committee, and a Technical Committee deals with methods, standardisation, and other technical features of testing. The National Physical Laboratory is represented on this last committee to preserve the liaison with the Department of Scientific and Industrial Research that was established when the Association was formed. The work of the Association during the past 21 years is an outstanding example of collaboration between otherwise competing firms to their common benefit.

The methods of testing used by the A.S.T.A. provide a common interpretation of the relevant British Standards and the basis of these methods

has been adopted by the International Electrotechnical Commission in their recommendations. At present, however, international co-operation is limited to an exchange of testing information between the A.S.T.A. and K.E.M.A. in Holland. It is to be hoped that other countries will establish similar national organisations and that an international agreement will be reached on the interpretation of the various national standards. However, it is doubtful whether a single standard could ever be adopted internationally since the requirements of standards in highly industrialised and heavily populated countries are far more rigid than those in underdeveloped countries. Nevertheless, some form of international agreement would clearly be beneficial.

WORKING WITH EURATOM

At first sight the benefits from the recent agreement between this country and Euratom to collaborate on thermo-nuclear research appear to be one-sided. But though it has received less publicity and is less advanced than experiments with ZETA, a large amount of work is being carried out on thermonuclear reactions under the auspices of Euratom in Continental laboratories. Since investigations in this field are now being concentrated on basic scientific problems rather than towards staging a dramatic "breakthrough," there are obvious advantages in avoiding duplication of effort.

With the improved fuel position, Euratom is primarily interested in getting wide practical experience of the various types of power reactor now available. A Calder Hall type reactor is under construction in Italy and Euratom scientists are working here on the advanced gas cooled reactor project. Further collaboration is likely on fast reactors. But, as M. Hirsch, president of the Euratom Commission, emphasised, Euratom countries will in less than 20 years have to "embark on a very large nuclear programme." The present plans for collaboration and exchange of staff are the best assurance that British industry will share in future commercial benefits.

GENERATION AT DRAKELOW

The construction of the second generating station at Drakelow Park, near Burton-on-Trent, is well advanced and a description of the main plant items appears in this issue. When completed, it will accommodate four 120 MW units operating at steam conditions of 1,500 p.s.i. and 1,000°F. The site will be further developed by the construction of a third station to have an installed capacity approaching 1,500 MW, making an aggregate site capacity of well over 2,200 MW. Drakelow will thus have the largest concentration of generating plant in Europe.

Decisions to group generating plant in this manner might well, at one time, have been opposed on grounds of national security, but with the growing strength of the country's supply network, the deciding factors are now largely technical. Fuel can conveniently be transported to this site by rail or road from local coalfields and the presence of extensive gravel pits adjacent to the station will, it is anticipated, provide adequate ash disposal facilities for 25 years' operation of the "A" and "B" stations. Cooling water is obtainable from the River Trent, but both stations have been designed for operation using river water and/or the four cooling towers which have been constructed.

The present policy of the Central Electricity Generating Board towards installing generating units of increasingly high individual capacity is well illustrated by the three Drakelow stations. The first, described in the *Electrical Review* dated 29th July, 1955, contains four 60 MW sets operating at similar steam pressure and temperature conditions to those in the station under construction, while each of the first units to be installed in the "C" station is to have an output of 350 MW and steam will be supplied to them at 2,400 p.s.i. and 1,055°F. Details of these turbo-generators, which are the largest single shaft units so far ordered in this country, were given on page 759 of our 27th November issue.

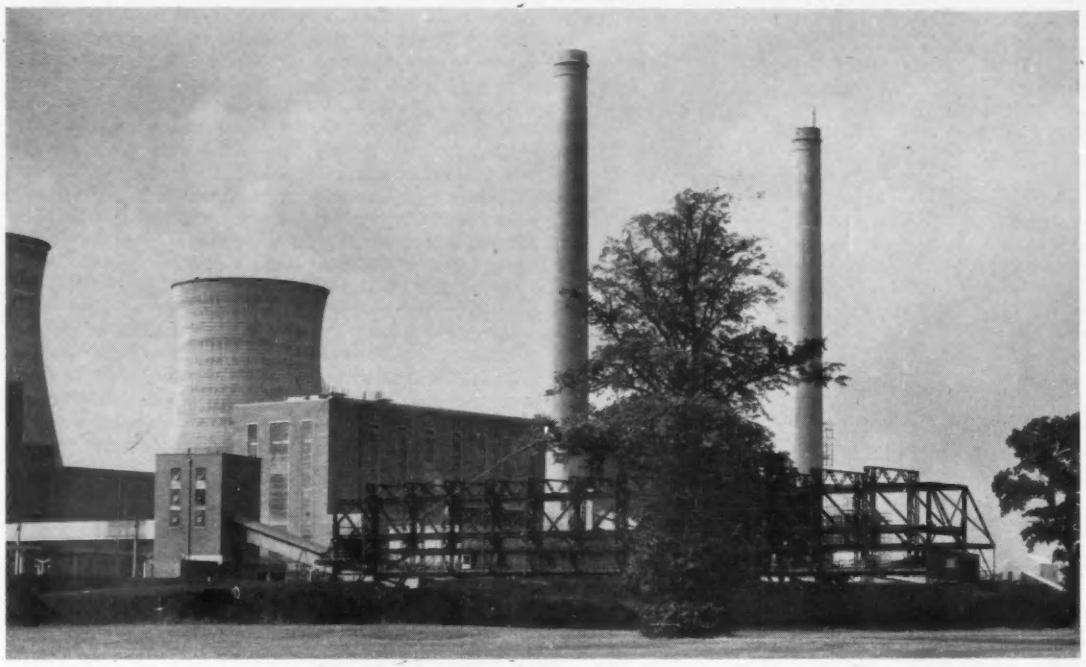
IMPORTED DOMESTIC APPLIANCES

Although we have previously warned our readers about the colour coding of three-core flexible cords attached to imported appliances (see *Electrical Review*, 21st August, 1959, page 56), we feel that in view of several recent instances of electric shock we should raise the subject again. The attention of all those who have any dealings with imported domestic electrical appliances, photographic and projection equipment, tape recorders and so forth, is urgently directed to the risks involved if the colour coding of the cores of the flexible cord with which such apparatus is furnished differs from that set out in the I.E.E. Wiring Regulations. These regulations state that the earth connection should be green, the live connection red and the neutral connection black.

The risk is most acute if the flexible cord provided with the apparatus has a red earth connection; this is particularly common with German equipment. If the user follows established British practice and connects this core to the terminal of a British connecting plug which may itself be marked red, and then inserts the plug into a normal British socket, the exposed metal parts of the imported apparatus will be "live." This obviously represents a serious hazard to the user.

The attention of importers and wholesalers known to be handling foreign apparatus fitted with flexible cords which do not conform with British practice in respect of colour coding has already been drawn by the Home Office Central Advisory Committee on Safety in the Home to this situation. We cannot emphasise too strongly that all vendors and users of imported apparatus should inquire as to the nature of the flexible cord provided with that apparatus. Probably the best way of dealing with the danger is to connect new flexibles to this apparatus, but that, of course, involves many complications.

We extend to all our readers our
Best Wishes for Christmas
and the Coming Year



Drakelow "B" Power Station

Details of the Layout, Boilers and Generating Plant

THE first of the four 120 MW turbo-alternator/boiler units being installed in Drakelow "B" generating station was commissioned on 24th April, 1959. The station is situated adjacent to the "A" station, described in the 29th July, 1955, issue of the *Electrical Review*, on a 1,012 acre site in Drakelow Park nearly three miles south of Burton-on-Trent. When completed, the two stations will have a combined generating capacity of 720 MW, to be increased later by the construction of a third station of about 1,400 MW capacity scheduled for this site. The steam conditions at the turbine stop valve in the "B" station are 1,500 p.s.i.g. at 1,000°F, with single-stage reheating to 1,005°F at 367 p.s.i.g. at the reheater outlet, and a final feed temperature of 435°F at the economiser inlet.

The site, which is on the south bank of the River Trent, was formerly parkland and comprises a 15ft thick layer of sand and gravel over Kuyper marl subsoil. Access is obtained from the main Burton to Walton road which passes on the south-east side of the station, while there is a rail connection between the coal storage and handling plant on the north side of the station and the main Burton to Leicester line. The contract for site clearance and the main foundations was placed in January, 1955, work beginning in April, and it is expected that the fourth set will be commissioned in the last period of 1960. The estimated total cost of the completed station is nearly £24 million, representing £49·86 per kW of installed capacity.

The turbine room, constructed of reinforced concrete frames with brick cladding and having a pre-cast concrete roof, is 737ft long by 70ft wide and 90ft 6in high. A 150-ton lifting capacity crane, manufactured by Sir William Arrol & Co., Ltd., has been installed together with an auxiliary crane of 25-ton capacity by the Vaughan Crane Co., Ltd. An auxiliaries bay between the turbine room and boiler house, 730ft in length, 55ft in width and 66ft high, houses feed pumps, evaporators, air compressors, bearing cooling water pumps and two unit control blocks. Each control block comprises a switch room housing the main 3·3 kV switchgear for the units, a cable marshalling room, a dust-tight enclosure for the relays and associated equipment for automatic combustion control and from which access can be obtained to the underside of the control desks for maintenance, and, at operating level, the control room housing control panels, control desks and recorder boards for two units. The de-aerators are mounted above this bay.

The boiler house is 578ft long by 90ft wide and 146ft high, of steel-framed construction with brick cladding and a pre-cast concrete roof, and an extension some 32ft wide and 67ft high houses the air heaters and forced draught fans. The combined building volume is equivalent to 35·2 cu ft/kW. To the rear of the boiler house extension are the dust extraction plant, induced draught fans and two brick chimneys, each 330ft high on a reinforced concrete stool 70ft in height, giving a total height of 400ft, and having an exit diameter of 19ft 6in.

Three of the four cooling towers for the "A" and "B" stations have been constructed, two for the "B" station being sufficient for half the station capacity, the remaining sets being cooled by water taken from the

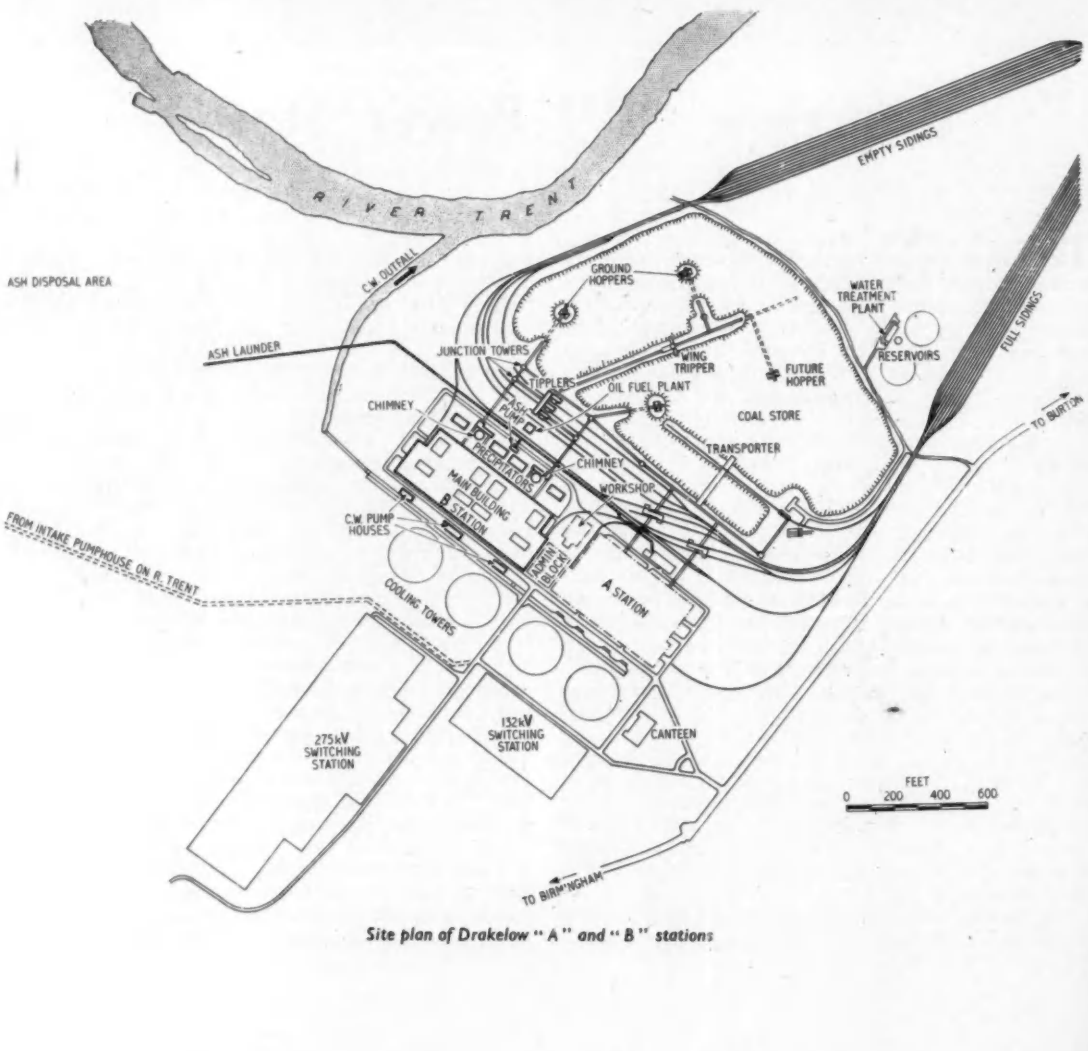
River Trent. The towers were built by the Davenport Engineering Co., Ltd., and each is 307ft high, has a base diameter of 233ft, a throat diameter of 137ft and a top diameter of 146ft. Of ferro-concrete construction on part-piled foundations and with timber slats, each has a normal capacity of 3,820,000 gal/hr cooling through a 17°F range.

The administration block, housing the main control room and administration offices, serves both stations and is situated between them, while the maintenance workshops and stores are to the rear of this building. Since both stations are operated under the one administration, and also make common use of some of the installed facilities, the units in the "B" station are numbered 5, 6, 7 and 8, following in sequence after the four 60 MW units in the "A" station. The site plan shows the position of the various other ancillary buildings.

Coal and Ash Handling

Slack with a small percentage of slurry is used as fuel for the station, obtained from the neighbouring South Derbyshire coalfield and the Leicestershire and Nottinghamshire coal areas which are relatively close. The calorific value is within the limits of 7,500 to 11,000 B.Th.U./lb. The daily consumption of the four boilers will average 5,600 tons. Main deliveries to the station are by rail, dealt with by three side discharge wagon tipplers having weighing facilities, each of 500 tons/hr capacity, manufactured by Mitchell Engineering, Ltd., who also made the mechanical wagon handling plant. From the tipplers coal can be taken direct by belt conveyors, manufactured by International Combustion Products, Ltd., to the four 1,300-ton capacity boiler bunkers at a total rate of 1,000 tons/hr, where it is discharged by travelling trippers, or to store where a travelling wing tripper operates on a conveyor running the full length of the coal storage area, spreading being carried out by mobile coal-moving equipment, which includes two Michigan tractor shovels fitted with 5 and 8 cu yd buckets respectively.

The coal is reclaimed from store by this equipment through three ground hoppers, each of 500 tons/hr capacity, and provision has been made for a fourth, if required later. Coal is taken from two of these hoppers by conveyor direct to the station bunkers, and from the others to the main reversible store conveyor. Road-borne coal is discharged either direct to a ground hopper or to store. The three tipplers and wagon handling plants are operated from control rooms above the three wagon tipplers. Two marshalling yards have been provided, handling full and empty wagons and common to both "A" and "B" stations, shunting being carried



Site plan of Drakelow "A" and "B" stations

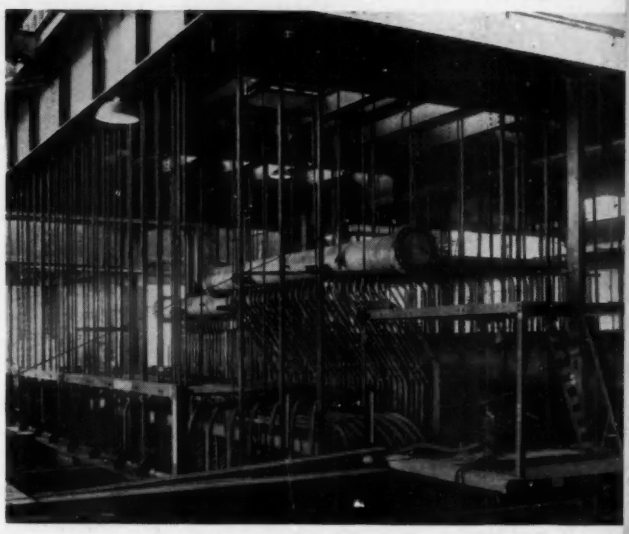
out by three Ruston-Hornsby diesel locomotives. Magnetic separators are fitted on the conveyor belts feeding Nos. 5 and 6 boiler bunkers to remove tramp iron and trash, and thus prevent damage to the "Lopulco" mills associated with No. 5 boiler, the ball mills on the other boilers making such a precaution unnecessary.

The boiler associated with No. 5 set is of International Combustion, Ltd., manufacture and the other three boilers, Nos. 6, 7 and 8, are being built by Foster Wheeler, Ltd. Coal for No. 5 boiler is taken from the bunker and passed through rotary table feeders to five "Lopulco" suction type roller mills. Each mill, which is driven by a 220 h.p., 1,485 r.p.m. Laurence, Scott & Electromotors motor, has a capacity of 29,700 lb/hr, four only being required to maintain full load on the boiler. The pulverised fuel is taken from each mill by a Keith Blackman paddle wheel type exhauster fan, driven by a 240/70 h.p., 1,470/960 r.p.m. Laurence, Scott motor, to twenty, tilting type, 7,800 lb/hr burners fitted in the corners of the combustion chamber and arranged for tangential firing. Twelve retractable oil burners are fitted, three at each corner, with automatic electric torch ignition. These are supplied with oil at 275 p.s.i. and 255°F by two 11,000 lb/hr pumping and heating sets, each having 330 kW heaters, from two 70 ton capacity storage tanks. When operating on the oil burners only, the boiler has a steaming capacity of 80,000 lb/hr. The oil fuel equipment for all four boilers in the "B" station is being supplied by the Wallsend Slipway & Engineering Co., Ltd., and Associated British Combustion, Ltd.

Air is taken from the top of the boiler house, at 90°F when the boiler is operating at continuous maximum rating, by two Davidson backward aerofoil bladed, single-side inlet, constant speed forced draught fans, each delivering 147,000 c.f.m. at 10·49in w.g., and passed through two Howden-Ljungstrom rotary air heaters. The fans are driven by 496 h.p., 740 r.p.m., 3·3 kV Laurence, Scott motors. The primary air is taken from the ouput side of the heater and passed to the p.f. mills through a further heater of the plate type to assist coal drying. The secondary air is also taken from the heater output to the p.f. and oil burners.

Coal is taken from the bunkers of the Foster Wheeler boilers for Nos. 6, 7 and 8 units to three double-ended 59,050 lb/hr ball mills for each boiler. Only two mills, which are driven by 600 h.p., 369 r.p.m., 3·3 kV Laurence, Scott motors, are required for full-load operation, the third being standby. Two paddle wheel Keith Blackman exhauster fans, driven by 120 h.p., 1,475 r.p.m., 3·3 kV Lancashire Dynamo motors, transfer the fuel from each mill to six of the 18 intervane type, 10,000 lb/hr, p.f. burners mounted on the front combustion chamber wall of each boiler. A retractable oil burner having high energy discharge type ignition is fitted in the centre of each p.f. burner. The oil is supplied to these burners at a reduced pressure of 40 p.s.i. at 240°F, air for atomisation being supplied at a pressure of 100 p.s.i.g. from two 100 per cent duty Broom & Wade air compressors.

Each boiler has a steaming capacity of 30,000 lb/hr when operating on oil only. The primary and secondary air system is similar to that installed on No. 5 boiler, with the exceptions of the f.d. fan ratings, again two for each boiler, but of 128,500 c.f.m. at 8·66in w.g., each driven by 408 h.p., 742 r.p.m., 3·3 kV Lancashire Dynamo motors, and the use of Howden tubular type primary air heaters. Air is also taken from the output of the heaters

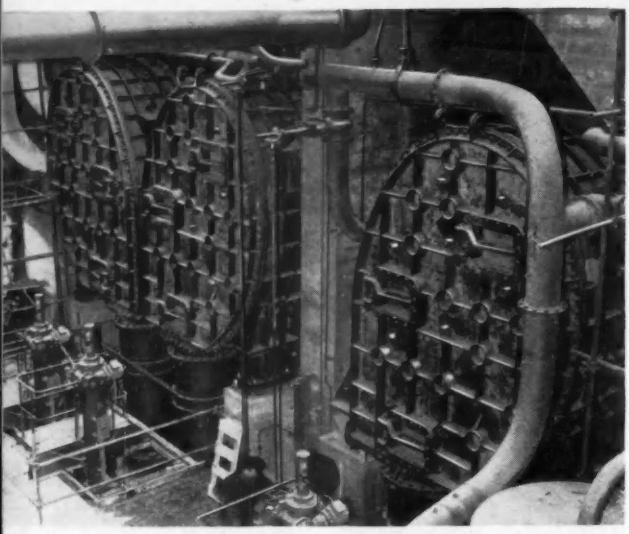


Construction work on No. 6 boiler, showing the drum

to tertiary nozzles in the p.f. burners to give increased turbulence if required.

After combustion ash and clinker precipitated from the combustion chambers are collected in a dry refractory-lined ash hopper underneath each boiler. To aid disintegration and ejection of the hopper contents, ten quencher nozzles, each having a water flow of 10 gal/min, are provided in each hopper for selective use as fuel conditions dictate. The hopper contents are worked out by high-pressure water jets, 12 in No. 5 boiler and 15 in Nos. 6, 7 and 8, issuing from nozzles set at hearth level and conveyed to the ash sump by further jets from nozzles in the removable nickel/cast-iron-lined sluiceways. The three 50 per cent duty 1,900 gal/min Gwynnes water sluicing pumps are driven by 230 h.p., 1,475 r.p.m., 3·3 kV Lancashire Dynamo motors.

The dust and grit carried by the flue gas are removed by Davidson centrifugal collectors and electrostatic precipitators supplied by the Sturtevant Engineering Co., Ltd., and Simon-Carves, Ltd., in both cases the fines dropping into storage hoppers. The fines are then removed by vacuum, induced by hydraulic ejectors, permitting the air-borne solids to mix with the ejector water to form a slurry, which is conveyed to the dust sump by gravity along brick-lined sluiceways. Similarly, fines deposited in hoppers underneath the economiser pass are transferred to the dust sluiceway. Dust and ash slurries are removed from the respective sumps, by three 100 per cent duty 2,200 gal/min Gwynnes ash pumps, each driven by a 90 h.p., 415 V Lancashire Dynamo motor, and two 100 per cent duty 1,900 gal/min Gwynnes dust pumps, each driven by 110 h.p., 415 V Lancashire Dynamo motors, and transferred to a disposal site comprising old, existing and proposed gravel pits covering an area of 25 acres, estimated to be adequate for 25 years' operation of the combined "A" and "B" stations. Two 100 per cent duty grinders driven by 7·5 h.p. Lancashire Dynamo motors are installed. Excess slurry from the ash and dust sumps is taken to an overflow sump, from which it is taken by two Gwynnes pumps driven by 30 h.p., 415 V Lancashire Dynamo motors, discharging in the ash launder of the "A" station. The



Each twin-shell three-flow condenser has 85,000 sq ft of cooling surface

ash and dust handling plant was supplied by John Thompson Industrial Constructions, Ltd.

Steam Raising Plant

Four single-drum reheat boilers, each with a maximum continuous evaporative capacity of 860,000 lb/hr when supplied with feed water at a temperature of 435°F at the economiser inlet, will be accommodated in the completed station, each connected to its respective turbine on the unit principle. The boilers are of the radiant type, having primary and secondary convection superheaters, convection reheaters, economisers, main and mill air heaters, forced and induced draught fans, fuel pulverising plant and automatic oil burning equipment. In addition, Nos. 6, 7 and 8 boilers have radiant primary superheaters. The steam conditions at the superheater outlet are 1,600 p.s.i. and 1,010°F, with reheating from 697 to 1,005°F at 367 p.s.i. between the h.p. and i.p. cylinders of the turbines.

The I.C.L. boiler for No. 5 set is suspended from the roof steelwork, the drum being suspended separately and taking only the weight of the downcomers. The fully water-cooled furnace has a volume of 82,400 cu ft, and the tubes are 3in in diameter. Five downcomers, one 11½in bore and four 10½in bore, supply water from the drum to four furnace wall lower headers, from which it is returned to the drum via the furnace walls. After the steam/water mixture enters the drum, it passes through centrifugal steam separators and wire mesh dryer grids before being distributed to the superheater inlet headers.

The primary self-draining superheater, constructed by the Superheater Co., Ltd., is in two stages, using 1¾in o.d. 2 s.w.g. thick tubes of mild steel, and 5 s.w.g. thick 1 per cent Cr, ½ per cent Mo alloy steel tubes respectively, while the secondary pendant superheater is also of two stages embodying 2in o.d. 0 s.w.g. thick 1¼ per cent Cr, ½ per cent Mo steel tubes and 1⅞in o.d. 1 s.w.g. and 2 s.w.g. thick 2¼ per cent Cr, 1 per cent Mo tubes. The convection reheater is of the two-stage self-draining type having 1¾in o.d. 8 s.w.g. thick mild steel and 1 per cent Cr, ½ per cent Mo steel tubes. Both the reheater and primary superheater are situated in the rear gas pass of the boiler, the reheater being on the upstream side of the superheater. The reheater occupies the full width of the boiler, but only about four-fifths of the depth, the remaining fifth being allocated to the gas by-pass. The superheater, however, occupies the full width and depth of the rear pass.

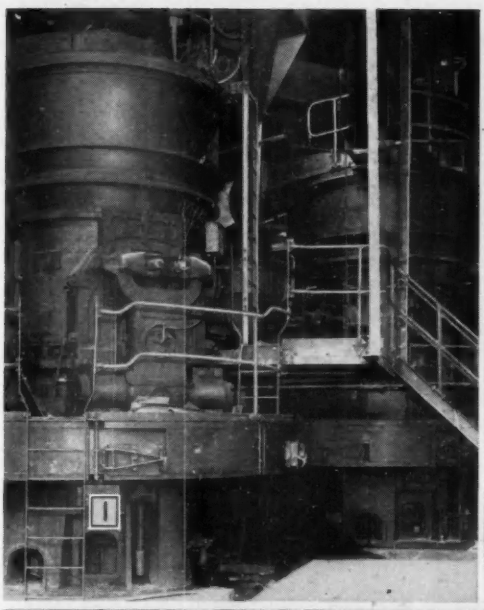
The boiler is equipped with automatic combustion control using an "Electroflo" pneumatic/hydraulic system. Variations in main steam pressure are sensed and transmitted to the forced draught fan inlet vane controls. Variations in forced draught alter the combustion chamber pressure which controls the induced draught fan inlet vanes to maintain the required combustion chamber suction. Fuel is fed to the p.f. mills by variable-speed table feeders which are controlled by an air signal from the steam pressure element. In addition, the air/fuel mixture swept through the mill is varied by the exhauster fan speed controlled by a similar air signal. A drop in steam pressure calls for a higher rate of combustion, and initiates more forced draught for combustion, an increased amount of primary air/fuel mixture through the mills and a greater quantity of induced draught to take away the products of combustion.

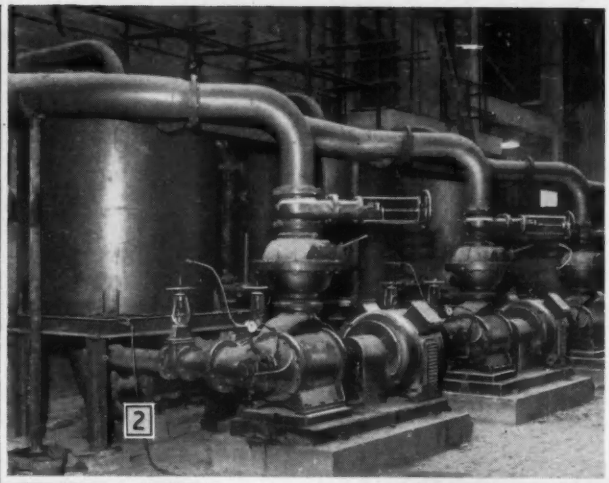
The combustion primary air flow through the mill air heater is controlled by one damper for every five mills, positioned in a common duct and pneumatically operated, the operation being initiated by a common mill suction measurement. This system is controlled from a master auto/manual station or by individual auto/manual stations influencing the i.d. fans, f.d. fans, exhausters and feeders, all situated on the unit control desk. A Lockheed hydraulic damper control system enables selected isolating and regulating dampers to be operated from the unit control room.

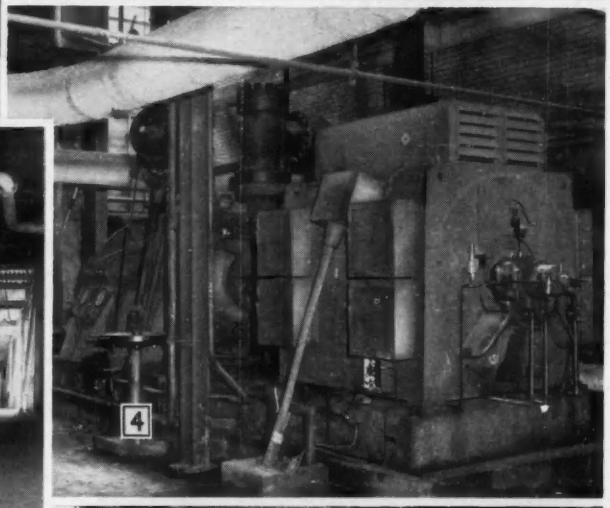
A Kent system of superheat and reheat steam temperature control is provided. The superheat and reheat superheat are controlled by temperature recorder controllers to within ±15°F, initiated by thermocouples in the left- and right-hand superheated and reheated steam pipes. The main superheater control is by an interstage desuperheater, while reheat control is by tilting burners, with the provision of emergency use spray desuperheaters in the reheater inlet pipework. Gas by-pass dampers and gas recirculation fans allow the temperatures at the superheater and reheater outlets to be varied manually under major operating changes. The main steam temperature controls are pneumatically operated from the panel-mounted steam temperature recorder controllers. These incorporate auto/manual stations on the unit control desk adjacent to the remote manual stations controlling the gas by-pass dampers and reheater spray desuperheaters.

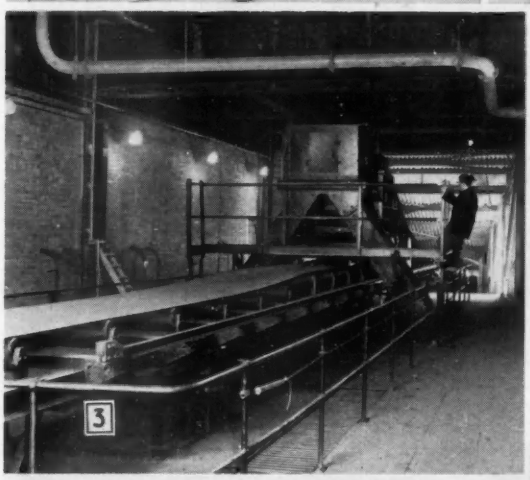
The Foster Wheeler boilers for Nos. 6, 7 and 8 units are also supported from the roof steelwork, the drum carrying the rear furnace wall tubes being supported separately. The radiant and convection superheaters, reheaters, headers and downcomers are independently supported from the roof. The fully tubed wall furnace has a volume of 76,800 cu ft, using two and three inch diameter tubes, and is of the twin furnace type, formed by the fitting of a water-cooled division wall. The side and rear walls are also water-cooled. The front wall forms the radiant superheater, fed from the temperature control headers. Down-flow tubes take the steam to an intermediate header at the bottom of the wall and up-flow tubes return the steam up the wall, across the top of the furnace and part way down the rear gas pass to the radiant superheater outlet header.

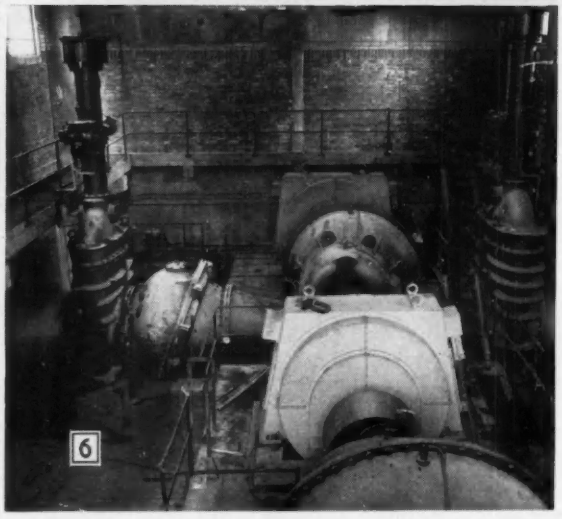
Six downcomers, four of 12in bore and two of 10in

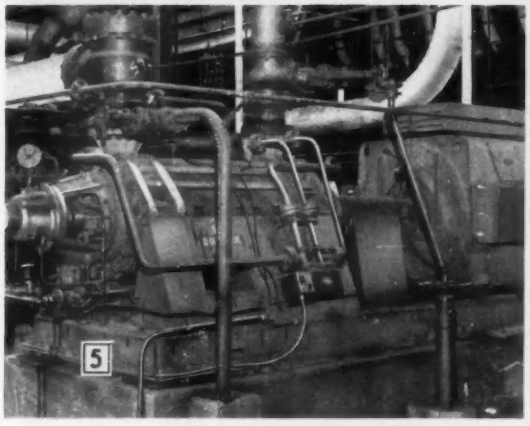




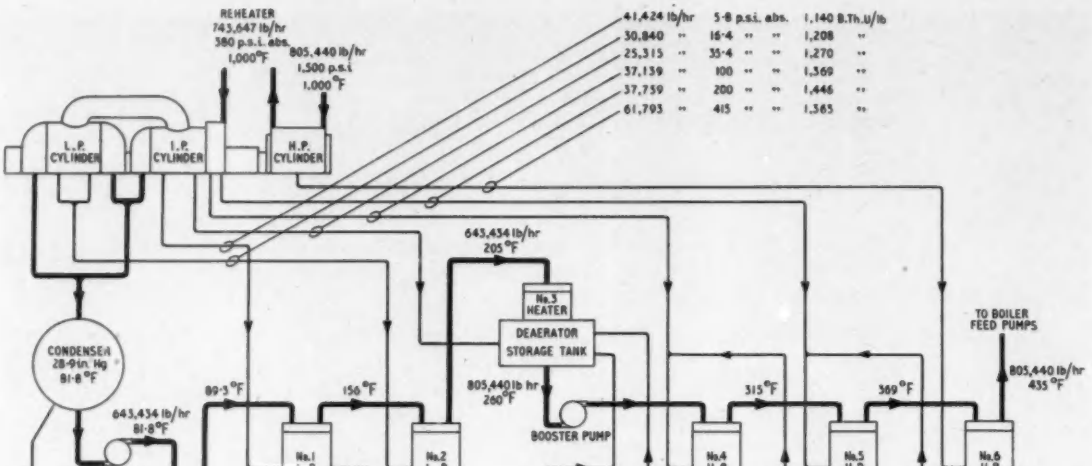








1. *Two of the five "Lopulco" fuel pulverising mills for No. 5 unit.* **2.** *Three 50 per cent duty air extraction pumps are installed for each unit.* **3.** *Coal is discharged into the boiler bunkers by a travelling tripper.* **4.** *Each main feed pump is driven by a 2,700 h.p. motor.* **5.** *A seven-stage centrifugal type booster feed pump.* **6.** *Interior of one of the three cooling water pump houses*



Heat flow diagram for 120 MW turbo-generator set at m.c.r.

bore, supply water from the drum to four furnace wall lower headers, one of which feeds the division wall, the water being returned to the drum via the furnace tubes. The steam/water mixture enters the drum through a system of horizontal centrifugal separators and transverse chevron dryers, before being passed to the radiant superheater via the temperature control headers.

All three sections of the superheater can be drained. The radiant section is formed of 2in o.d. 2 s.w.g. 1 per cent Cr and ½ per cent Mo or 2¼ per cent Cr and 1 per cent Mo tubes, the primary convection section of 2½in o.d. by 1 s.w.g. 2¼ per cent Cr, 1 per cent Mo tubes and the secondary convection section of 2in o.d. by 3 s.w.g. and 2in o.d. by 6 s.w.g. 18/8 chrome nickel tubing. The three-stage drainable convection reheater incorporates 2½in o.d. tubes, the first stage using 10 s.w.g. mild steel tubes, the second stage 10 s.w.g. 2¼ per cent Cr and 1 per cent Mo tubes and the third stage 8 s.w.g. 18/8 chrome-nickel tubes.

Both the primary superheater and reheater are situated in the rear gas pass of the boiler, the reheater being on the downstream side of the superheater and occupying the full width of the boiler and about three-quarters of the pass depth, the remaining space being allocated to the gas by-pass.

Each Foster Wheeler boiler is equipped with an Electroflo pneumatic/hydraulic automatic combustion control system in which steam pressure variations are used to operate the f.d. fan inlet vane controls, and the i.d. fan inlet vanes are controlled to maintain the required combustion chamber suction against combustion chamber pressure alterations caused by variations in forced draught. Fuel is fed to the p.f. mills by two-speed table feeders which are controlled by an air signal varied by coal level in the mill. In addition, the air/fuel mixture passing through the mill is varied by the mill output dampers, which influence the effect of the constant-speed exhausters, controlled by an air signal from the steam pressure element. The higher combustion rate called for by falling steam pressure is again provided by more forced draught, an increased amount of primary air/fuel mixture and more induced draught.

The combustion primary air flow through the mill air heater is controlled by individual mill suction dampers controlled by air signals initiated by individual mill suction measurements. Primary air/fuel mixture temperature is correctly maintained at each mill by a tempering air damper controlled by an air signal initiated by an averaged measurement of mill outlet temperature, thus regulating the influx of tempering air, taken from the f.d. fan discharge, to each mill. This control system is operated from a master auto/manual control station or by individual auto/manual stations governing i.d. fans, f.d. fans, exhausters, mill suction and mill tempering air, all situated on the unit control desk. A Lockheed hydraulic damper control system enables selected isolating and regulating dampers to be operated from the unit control room.

An Electroflo superheat and reheat steam temperature control system is provided. The main superheater control to within ±15°F is of the condenser type and is carried out in headers between the drum and the radiant superheater. Steam temperature at the reheater outlets is automatically controlled to ±15°F by by-pass dampers, with the provision of emergency use spray desuperheaters in the reheater inlet pipework. The main steam temperature controls are pneumatically operated from the panel-mounted steam temperature recorder controllers, which incorporate auto/manual stations on the unit control desk.

For both makes of boiler, the drum water level is maintained by a pneumatic/hydraulic "Electroflo" three-element system which takes into account drum level, steam flow and feed flow. The steam flows, which are 805,444 lb/hr at the superheater and 743,647 lb/hr at the reheater at the turbine c.m.r., are measured and balanced on a beam which adjusts the signal controlling the opening and closing of the feed regulating valves, this signal being biased by the drum level element.

Each boiler has two backward aerofoil bladed, two-

speed Davidson induced draught fans with double side inlet ducts. Those operating with No. 5 unit are each rated to deliver 229,500 c.f.m. of gas at 16·65in w.g. and 254°F at boiler c.m.r., driven by a 1,265/720 h.p., 985/740 r.p.m., 3·3 kV Laurence, Scott motor, while those installed in Nos. 6, 7 and 8 units each deliver 198,000 c.f.m. of gas at 10·14in w.g. and 225°F at boiler c.m.r., and are driven by 762/477 h.p., 740/590 r.p.m., 3·3 kV Lancashire Dynamo motors. Both forced and induced draught fans have inlet control gear, housed in an extended fan inlet cone, consisting of a series of vanes fitted to steel spindles carried in carbon-lined spindle bearings. The vanes are operated from remote control points.

Electrically operated Hopkinsons retractable soot blowers arranged for remote sequence control are fitted to all boilers. On the No. 5 unit, steam for soot blowing is taken from the intermediate stage on the superheater, at a pressure of 1,665 p.s.i.g., and on this unit 38 soot blowers have been fitted, 20 in the furnace water walls, six in the superheater, four in the reheater and eight in the air heaters. On the remaining three units the steam is taken from the primary convection superheater at a pressure of 1,615 p.s.i.g. and fed to 20 soot blowers, 12 in the furnace, four in the superheater and four in the reheater.

The main and reheat steam pipework between the boilers and turbines, supplied by Stewarts & Lloyds, Ltd., for units 5 and 6 and John Thompson (Pipework), Ltd., for units 7 and 8, has butt welded joints, with valves installed on each reheater inlet and outlet to isolate the reheater for hydraulic tests. The left- and right-hand main steam pipes are cross-connected, and similarly the right- and left-hand reheat return pipes to the turbines are cross-connected to permit on-load test tripping of either of the turbine stop valves or either of the intercepting valves of the reheat lines.

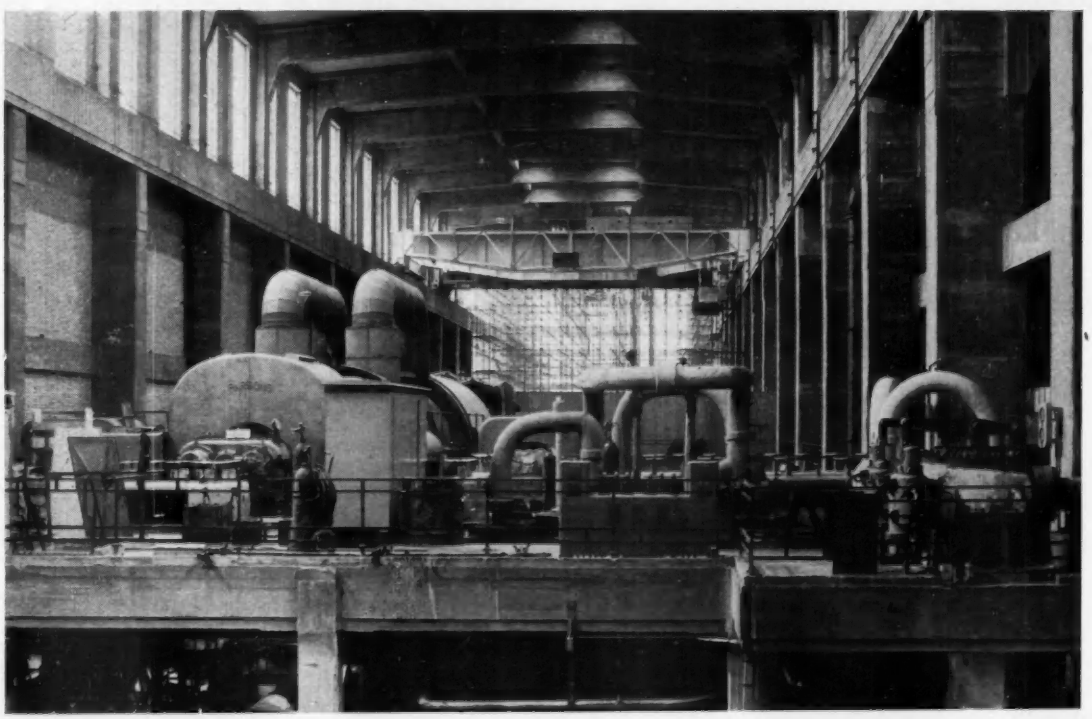
Generating Plant

The four C. A. Parsons & Co. 120 MW sets are arranged longitudinally in the turbine room. The turbines are of the three-cylinder impulse reaction type with a double-flow l.p. cylinder, running at 3,000 r.p.m. Each machine has 13 h.p. stages, including a single velocity compounded impulse stage, 19 i.p. stages and eight l.p. stages in each of three turbines, the steam to the l.p. cylinder being taken in twin overhead pipes from a point about two-thirds along the i.p. cylinder, the remainder of this cylinder containing a single eight-stage l.p. turbine. After passing through the h.p. cylinder, the steam is returned to the boiler for reheating before entering the i.p. cylinder. The stop valve steam conditions at the turbine are 1,500 p.s.i.g. and at 1,000°F, and steam is reheated to 1,000°F at 360 p.s.i.g. at the i.p. cylinder inlets.

Solid flanged couplings are fitted between the h.p., i.p. and l.p. turbine shafts and the alternator shaft. The anchor point is between the i.p. and l.p. cylinders, and sliding feet with locating keys, allowing axial movement of the casings without transverse movement, have been installed at the intermediate bearing and steam end pedestals. Main steam chests are fitted externally on each side of the h.p. cylinder, each chest containing a combined runaway and stop valve, and two governor valves, while external reheat steam chests on each side of the i.p. cylinder each house duplicate intercepting valves.

The main speed governor controls the high-pressure steam admission valves, and an independent auxiliary governor is fitted to regulate the intercepting and un-

The turbine hall under construction, with No. 5 set in the foreground



loading valves, an arrangement allowing the auxiliary governor to be set independently of the main governor. If the machine suffers a sudden loss of load, the following operation sequence of the complete valve system occurs. The four governor valves controlling the flow of steam to the h.p. turbine, arranged in parallel and controlled by the main governor, close simultaneously. The runaway stop valves, which are controlled by the overspeed emergency governor, cover the governor valves. The high oil pressure which normally holds the intercepting valves fully open is released at a predetermined overspeed by the auxiliary governor control system, and the valves close rapidly under the action of their springs, preventing stored steam in the reheater system entering the i.p. turbine. Also at this value of overspeed, the unloading valves open automatically, releasing the steam in the reheater system to atmosphere. The normal function of these valves is to prevent overheating in the h.p. cylinder which would occur when the intercepting valves closed unless steam pressure in the h.p. cylinder was relieved. They also act as a safeguard to prevent excessive overspeed if the intercepting valves fail to close.

The main oil pumps consist of three helical gear pumps driven from the main turbine shaft, a lubricating pump supplying oil at a pressure of 20 p.s.i. to the main bearings, a power pump discharging oil at 100 p.s.i. for operating the steam valves, and a pilot and seal oil pump delivering oil at 70 p.s.i. for the operation of the pilot pistons of the main governor valves and supplying the generator hydrogen seals at a pressure reduced subsequently to 25 p.s.i. at the seals. An auxiliary oil pump, driven by an a.c. motor, has three pumps on the same shaft. The power and pilot and seal pumps are of the helical gear type and a centrifugal pump is used for lubrication. Centrifugal emergency lubrication and seal oil pumps are provided, driven by d.c. motors, with an a.c. motor-driven helical gear type hydrogen seal oil pump. The centrifugal turning gear pump is driven by an a.c. motor, and the a.c. motor-driven jacking oil pump is of the six-throw ram type.

Turbine supervisory equipment has been installed to measure h.p. and i.p. shaft eccentricity, shaft speed, bearing vibration, cylinder expansion, h.p., i.p. and l.p. differential expansion and shaft position, metal and steam temperatures, and the axial position of the h.p. shaft. In each case visual indication and continuous recording facilities have been provided on a local panel, with visual indicators also fitted in the unit control room.

From the double-flow exhaust of the l.p. turbine cylinder and the exhaust outlet from the l.p. turbine in the i.p. cylinder, steam passes into a twin-shell, three-flow surface type condenser which has a total cooling surface of 85,000 sq ft and is designed to give a vacuum of 28·9in Hg when supplied with 58,000 gal/min of cooling water at 55°F. Two 100 per cent duty horizontal two-stage a.c. motor-driven extraction pumps, rated at 770,000 lb/hr at 257ft head, are used to extract 570,839 lb/hr of condensate at a temperature of 81°F, while air is removed from the condensers by three 50 per cent duty, 251 lb of air per hour Mirrlees Watson pumps. For quick starting, a single Hick, Hargreaves air pump is fitted for each unit, capable of producing an absolute pressure not greater than 10in Hg in five minutes.

The extraction pumps discharge to an in-line regenerative feed heating train, comprising a drain cooler, three l.p. feed heaters, including a de-aerator, three h.p. bled steam heaters and an evaporator vapour condenser. There are two 100 per cent duty Harland booster feed pumps for each unit, passing the condensate to the h.p. heaters, each rated to deliver 965,000 lb/hr at a pressure of 550 p.s.i.g. and a temperature of 260°F. The pumps, which are of the seven-stage centrifugal type, are driven at 1,470 r.p.m. by 900 h.p. Harland motors. From the final h.p. heater the condensate is taken to the boiler feed pumps, two 100 per cent duty, 965,000 lb/hr Harland pumps being provided for each boiler. Those for No. 5 unit are of the seven-stage centrifugal type delivering at 1,950 p.s.i.g., 435°F, while eight-stage pumps are used for Nos. 6, 7 and 8 units delivering at 1,970 p.s.i.g., 435°F, all being driven by 2,700 h.p., 2,970 r.p.m. Harland motors. Both booster and feed pump motors are supplied from a single circuit-breaker, the booster pump running up to speed before the feed pump and thereby maintaining a positive pressure at the feed pump inlet.

The control panel for No. 5 set

Water Supplies

The boiler feed and make-up water is obtained from the River Trent. A John Thompson-Kennicott lime soda water softening plant and ammonia removal plant serves both the "A" and "B" stations. The plant comprises a precipitation unit with chemical proportioning gear, stabilising units and base exchange/ammonia removal units, with a capacity of 20,000 gal/hr. Softened water is contained in two pre-stressed concrete reservoirs, each of 1½ million gal capacity.

Water for the ash handling plant and condenser cooling is drawn from the River Trent through three pump houses, one containing a condenser and a tower pump for use with No. 5 unit, one housing two condenser and two tower pumps for use with Nos. 6 and 7 units, and one containing a condenser pump with provision for fitting a tower pump if required, for use with No. 8 unit. Water from the river and the tower ponds is taken from a pond suction culvert by the condenser pumps, which have their output sides commoned by 54in diameter piping, any pump being able to supply any condenser. The condenser output is taken through similar pipes to a discharge culvert and hence to the river. A sill maintains a level in this culvert from which the tower pumps draw water and pass it to the towers, the amount of tower cooling

employed being dependent on the load on the station. Each of the two towers is of sufficient capacity to enable one unit to operate at c.m.r.

The four 100 per cent duty horizontal constant-speed centrifugal condenser pumps, which are rated at 62,500 gal/min at 43·5ft head, are driven by English Electric 970 h.p., 297 r.p.m., 3·3 kV motors, and English Electric 3·3 kV motors, of 1,270 h.p. at 371 r.p.m., are also used for the three 100 per cent duty horizontal centrifugal constant-speed tower pumps, which can each deliver 62,500 gal/min at 57ft head. Both the tower and condenser pumps are being supplied by Drysdale & Co., Ltd. The c.w. treatment plant consists of two Wallace & Tiernan master vacuum solution feed chlorinators feeding both "A" and "B" stations. Each chlorinator is arranged for a maximum capacity of 250 lb of chlorine per hour and is designed for automatic intermittent operation governed from an electric programme clock control panel. The automatic rate controller enables an alternative treatment rate to be made for each unit, to suit c.w. conditions.

Generating Plant

Each of the hydrogen-cooled alternators generates at 13·8 kV and is rated for continuous operation at 120 MW at 0·9 power factor, with a coolant pressure of 15 p.s.i.g., distillate being used in four heat exchangers for hydrogen cooling. The air-cooled totally-enclosed main and pilot exciters are gear driven at 750 r.p.m. from the main alternator shaft. The Metropolitan-Vickers voltage regulating equipment incorporates an amplidyne generator excited by a magnetic amplifier which boosts or bucks the normal self-excitation of the main exciter to compensate for variations in the main alternator voltage. Facilities for change-over to manual control are provided when the main exciter is energised from the pilot exciter through a field rheostat.

Each alternator is solidly connected to a 13·8/295 kV, 125 MVA, OFW-cooled B.T.H. generator transformer by B.I.C.C. double angle section copper busbars on porcelain supports in a reinforced concrete flume. These transformers are connected by oil-filled Pirelli-General cables to the main 275 kV, 7,500 MVA air-blast Reyrolle switchgear. Unit auxiliaries are supplied from 13·8/3·45 kV, 10 MVA Crompton Parkinson and Bonar Long transformers, while station supplies are obtained from four 10 MVA, 132/3·45 kV transformers, two of B.T.H. and two of Yorkshire Electric Transformer manufacture, fed from the adjacent 132 kV substation. The 415 V auxiliary supplies are obtained from the 3·3 kV system through 1,000 kVA Denis Ferranti transformers. Reyrolle air-break 150 MVA single-busbar switchgear is used for 3·3 kV switching, and this company also supplied the 25 MVA air-break single-busbar switchgear for the 415 V circuits, while 415 V distribution fusegear and fuseboards were manufactured by South Wales Switchgear, Ltd. All motor contactor gear was supplied by the Metropolitan-Vickers Electrical Co., Ltd.

Each pair of turbo-alternator/boiler units is controlled from a unit control room situated in the auxiliaries bay midway between the pairs of machines and boilers, the necessary instruments and controls for the operation of the units being incorporated in desks and panels situated at turbine operating floor level. The main electrical control room for the 275, 132 and 3·3 kV systems of both stations is situated in the administration block and houses the generator load desk for the "A" station, the 275, 132 and 3·3 kV control panels, the "A" station river water and "B" station circulating water pump motor control desks, the 275, 132 and 3·3 kV systems alarm relay equipment panels, the automatic voltage regulators for the "A" station and the station generator relay panels and chlorinating programme clock for both stations.

The architects, and consulting engineers for the civil engineering work, were L. G. Mouchel & Partners, and the station was designed and engineered by the Construction Department of the Midlands Division of the C.E.G.B. (now part of the Midlands Project Group), the chief engineer of which was Mr. R. R. Maddock. The contractors for the main plant items are:—Boilers, International Combustion, Ltd., and Foster Wheeler, Ltd.; turbo-alternators, condensing and feed heating plant, C. A. Parsons & Co., Ltd.; coal handling plant, International Combustion Products, Ltd.; instrumentation and automatic control, Electroflo Meters Co., Ltd.; ash handling plant, John Thompson Industrial Constructions, Ltd.; main switchgear, A. Reyrolle & Co., Ltd.; generator transformers, the British Thomson-Houston Co., Ltd.

Acknowledgment is due to Mr. R. L. Batley, director of the Midlands and East Midlands Region, and Mr. O. S. Woods, divisional controller, East Midlands Division, of the Central Electricity Generating Board, for permission to publish this article, and to Mr. R. R. Maddock, now chief project engineer, Midlands Project Group, and Mr. H. Greenwood, station superintendent, and their staffs for invaluable assistance in the preparation of the material.

Conference on Medical Electronics

THE Electronics and Communications Section of the Institution of Electrical Engineers, in association with the International Federation for Medical Electronics, are organising the third International Conference on Medical Electronics which will be held at Olympia from 21st to 27th July, 1960.

The conference is planned to bring together members of the medical and electrical engineering professions so that each will gain a better understanding of the problems of the other; besides sessions for experts, there will also be less-specialised meetings to enable those who have no deep insight of the subject to increase their background knowledge. With the many recent advances both in electronics and medicine, it is generally recognised by members of both professions that discussions on medical electronics can do much to stimulate progress.

In conjunction with the conference the Institution is promoting an international scientific exhibition which will be held at Olympia at the same time as the conference, to enable research organisations, universities, hospitals and industrial organisations working in this field to display their latest developments.

At a recent Press conference, an indication was given of some of the subjects which will probably be discussed at the conference. These include the automatic control of artificial limbs and techniques involving the use of pills (8 mm diameter by 15 mm long) containing miniature radio transmitters. The Institution is inviting the submission of papers for consideration. Details of the requirements for these papers, and information about the conference itself, can be obtained from the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C.2. Full details regarding space at the exhibition can be obtained from the organisers, Industrial Exhibitions, Ltd., 9, Argyll Street, London, W.1. A full-scale catalogue and Medical Electronics Directory, containing descriptions of exhibits and a classified index and buyers' guide will be prepared.

Engineering in Europe

ABSTRACTS FROM FOREIGN TECHNICAL JOURNALS

IN the design of the rotor cage of a synchronous motor it is not sufficient for averages of the temperature rises of all the bars and short-circuiting rings to be used. The production of the rotor cage of brass bars of equal cross-section, and their distribution over the whole width of the pole shoe, leads particularly to non-uniform heating-up of the bars during the starting period. The use of bars of different electrical resistances and such an arrangement of the bars on the pole shoe that the bars of high resistance are at the centre and low-resistance bars outside will, under otherwise equal conditions, improve not only the utilisation of the central bars, but also result in an advantageous redistribution of the losses in bars and rings and reduce the temperature rise of the latter.

Furthermore, the short-circuiting rings should be of copper instead of brass, which reduces the temperature of the rings during starting and also leads to a redistribution of the losses in rings and bars. While replacement of the outside brass bars by copper bars reduces the bar temperature, it also extends the starting period. A design of the cage with few thick bars concentrated on the middle of the pole shoe, with the subtransient reactance of the condensers increased to about 80-90 per cent of the transient reactance (by increasing the leakage reactance of the bars), leads to the optimum temperature conditions achievable for the bars.—" The Temperature Rise of the Rotor Cage of a Synchronous Condenser on Asynchronous Starting," N. A. Polyak, *Elektrichestvo*, No. 9, pp. 41-46, 1959, in Russian.

Ladder Networks

A method is presented of calculating the impedances and admittances of a ladder network which was used as the most convenient representation of transformer windings under transient stresses. This is followed by the frequency investigations, clarifying the relations between the actual winding and its model or representation. The essential features of the paper are that the author leads from the symbolism of the operator method to its actual working and deals with the translation of the vector symbols into the mathematical expressions required for calculations and their practical handling.

The various cases possible according to the character and positions of the roots and zeros of the polynomials are investigated and the physical significance of these cases is clarified. Graphical short-cuts in the determination of the values of polynomials and roots are used and some of the typical results are arranged in graphs and tables, which enables the possible cases to be surveyed more quickly and clearly. Lastly, the importance and relationships of theoretical results and the results of surge tests, as well as service characteristics of transformers, are discussed at some length and some of the existing regulations are considered in relation to improvements in the light of more recent revisions of conventional ideas.—" On Polynomials, Ladder Networks and Surge Voltages in Windings," A. Pasi, *Energia Elettrica*, No. 8, pp. 692-712, 1959, in Italian.

Installation Protection

The two most frequently used methods of protection for electrical installations (simple earthing and multiple earthing) are efficacious only if the earthing resistances are kept between strictly defined limits, which is very difficult and often impossible. The fault-voltage method, patented as early as 1913, dispenses with the normal earthing and substitutes an " auxiliary earth " for it. This protection system is relatively easily installed. The core-balance system, which is an earth-leakage *current* protection, was patented in 1930, being developed from the generator differential protection. The safe operation of this device is, however, again conditional on a relatively low earthing resistance (e.g. 32·5Ω for a fault current of 1 A and 65 V contact voltage). Such a low value could not be reliably maintained, for example, when normally moist ground dries out, which is obviously always possible.

To obtain reliable protection under all possible conditions in " critical " installations, such as building sites, oilfields, mines, quarries, etc., a combination of the core-balance and leakage-current protection systems was developed. This is in principle a leakage-current protection system fitted with an additional core-balance release. This requires an " auxiliary earth " and a protective line, but provides reliable protection under all conditions. Furthermore, it is always possible to test the serviceability of the protective gear without producing an " artificial " leakage current. The commercial types of this new all-purpose protection are described and illustrated.—" A Combined Core-Balance and Fault-Voltage System as the most efficacious Contact-Voltage and Fire Protection," J. Prade, *Elektrotech. u. Maschinenbau* (E.u.M.), Vol. 76, No. 17, pp. 408-414, September, 1959, in German.

Test Transformers

The effect of the harmonics of the magnetising current on the curve form of the h.v. side of testing transformers was considered theoretically and confirmed by measurements on a testing transformer in four-stage cascade-connection. It was found that the comparatively high self-capacitances together with the leakage inductances might, under certain operating conditions, set up resonance conditions for harmonic components of the magnetising current.

If the testing transformer is not energised by " infinite " busbars, but by a separate generator, the conditions become even more unfavourable by the reaction of the leakage reactance of the generator to the " infiltrating " harmonics, which distort the curve form of this generator, unless its rating is far in excess of the required value. The resonance phenomena can be mitigated by the insertion of capacitances into the transformer circuit. To reduce the distortion of the h.v. curve to the minimum, it is advisable to remedy the actual cause of the harmonics by an appropriate design of the cores of the testing transformers, i.e. by a selection of core materials whose magnetisation curve runs more or less as a straight line through the range utilised.—" Distortion of the Form of the Voltage Curves of Testing Transformers by the Harmonics of the Magnetising Current," W. Matthes and R. Zahorka, *Elektrotech. Z. (E.T.Z.) A.*, Vol. 80, No. 19, pp. 649-653, October, 1959, in German.

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review*.

A.S.T.A. "COMING OF AGE"

THE Association of Short-Circuit Testing Authorities was formed in December, 1938, to co-ordinate tests and testing methods at stations owned by individual companies and to issue reports of performance and certificates of rating of switchgear. To mark the occasion, an illustrated book entitled "A.S.T.A.—21 Years of Progress" has been published by the Association. It describes the development of A.S.T.A., the various testing stations, types of equipment tested and the research work carried out by the Association.

The advent of the national grid in 1926 emphasised the need for adequate testing facilities and the first short-circuit testing station was built by A. Reyrolle & Co., Ltd., and commissioned in 1929. There are now seven other testing stations in this country owned by various other manufacturers, one of these stations being designed for the testing of fuses only.

The companies owning these stations are members of the A.S.T.A. whose affairs are under the control of a Council, a Management Committee and a Technical Committee; the National Physical Laboratory is represented on the Technical Committee. Mr. V. Watlington was chairman of the A.S.T.A. from its inception until 1947 when Col. B. H. Leeson, who was associated with the first British short-circuit testing station, was appointed chairman, a position he still holds. The facilities of the Association are also available to non-members for testing switchgear up to a limit of 33 kV and 750 MVA.

Apart from testing (up to 275 kV and 7,500 MVA), research and development work is carried out at the various stations. The Association is also playing an important part in endeavouring to obtain uniform international interpretations of national standards.

Anniversary Dinner

On the occasion of the 21st anniversary of the formation of the A.S.T.A., a dinner was held at the Savoy Hotel, London, on 9th December. The loyal toast and a toast to the heads of state of countries represented were proposed by Col. Leeson, who presided. Then Sir Willis Jackson, President, I.E.E., proposed the toast of the Association and in the course of his speech said that electrical engineers were very fortunate people. Their frontiers were ever moving forward: he instanced computers, transistors, guided missiles and nuclear reactors. The general public was apt to take for granted the less spectacular but important achievements such as the improvement of power station thermal efficiency, the reduction in the weight of generating plant per kVA, and the rise in the rupturing capacity of switchgear. Thus, the public was not aware of what the Association had done during the past 21 years although it was an outstanding example of collaboration of otherwise competing firms to their common benefit. The division of the electrical industry among so many firms had led to a lamentable duplication of effort; no individual concern could provide sufficient funds to attack the important problems. The A.S.T.A. had shown how common problems could be handled without losing the benefits of a free society. As a result we had short-circuit testing facilities not to be matched in any other country and had established a hall-mark for high-power switchgear.

Replying to the toast, Col. Leeson said that the Association had constantly conducted a crusade for the safety of the equipment, the manufacturers and the users. Out of the nettle danger the A.S.T.A. had plucked the flower of safety. Before the Association was formed H. W. Clothier and E. B. Wedmore had striven for a testing station, but the money could not be found. Eventually Clothier had established a station; others followed and in time they had established ratings after a long period of doubt. Col. Leeson paid a tribute to the work of the Electrical Research Association under Dr. W. B. Whitney in entirely new fundamental research and technique.

Co-operation with Other Bodies

Concurrently, the members of the A.S.T.A. went for both national and international collaboration, with the aid of the B.E.A.M.A. and the I.E.C., and within five years there was an international specification for testing to which the British Standards Institution conformed. In this connection he acknowledged their debt to K.E.M.A., the Netherlands testing authority. He also mentioned the help received from the National Physical Laboratory, Sir Lawrence Bragg and Sir Frank Smith.

Other countries were establishing bodies similar to the A.S.T.A. and these would be given the fullest information. He suggested the setting up of a panel of experts to arrive at an international arrangement.

Mr. J. R. Wilkinson, deputy chairman of the A.S.T.A. Council, proposed the health of the guests. Referring to Sir Willis Jackson, he said that one reason for the maintenance of the standard of the I.E.E. was the high calibre of its presidents. Mentioning Professor J. C. van Staveren, managing director of K.E.M.A., Mr. Wilkinson said that that body's new testing station was one of which any nation could be proud. Another eminent guest was Mr. C. R. King, chairman of the Electricity Council. The A.S.T.A. owed much to the help and co-operation of the electricity supply industry.

In responding to the toast Professor van Staveren supported Col. Leeson's appeal for uniform international testing rules; a committee of the I.E.C. should be set up for the purpose of securing such rules. Mr. King also replied to the toast and spoke of the value of the Association's work in ensuring the safety and continuity of electricity supply.

Data Processing System

A NEW high speed electronic data processing system known as "Orion" is being developed by Ferranti, Ltd. Construction of the prototype is well under way and work has commenced on the first production models. The system is fully transistorised and incorporates the latest "neuron" logical elements enabling complex systems to be built around the central computer with the minimum of components.

It is well known that a large computer is more economical than several smaller machines doing the same volume of work. The problem has been to keep a large machine and its equipments working at full capacity. In "Orion" this difficulty is overcome by providing full facilities for automatically sharing the time of the central computer between several programmes. This time sharing system ensures that the computer is always fully engaged even while peripheral transfers take place and that peripheral equipments are kept working at maximum speeds. This is done by special equipment which automatically selects programmes according to given priority levels.

New Books

Electric Circuit Theory. By F. A. Benson and D. Harrison. Pp. 371; figs. Published by Edward Arnold, Ltd., 41, Maddox Street, London, W.1. Price 30s.

This book is based on lectures given to undergraduate engineers and the text is correctly indicated by the title. There is no descriptive matter relating to machines or apparatus, but the circuit theory covers both the heavy current and the light current branches of electrical engineering. The first four chapters are devoted to an elementary treatment of d.c., single-phase and polyphase circuits. Much of this treatment is so brief that a beginner would find it very difficult to follow without the aid of either lectures or reference to other textbooks. These chapters are followed by two very good chapters on the use of complex notation. Other chapters deal with network theorems; coupled circuits; locus diagrams for current, impedance and admittance; non-sinusoidal waveforms; unbalanced polyphase circuits; transients in d.c. and a.c. circuits; diode and triode circuits, including amplifiers and oscillators; transmission lines, including filters; and electric machines.

Much of the text is extremely good, the sections on symmetrical components, transients and transmission lines, for example, and a valuable feature is the inclusion of numerous worked examples. It is impossible, however, to avoid the conclusion that the book has been hastily produced and inadequately edited. On page 2, one is confronted with the statement that efficiency is the ratio of *work* done to *power* supplied (my italics), Figs. 3.10 and 3.12 should be interchanged, $d\Theta$ is missing in an expression on page 59, on page 60 " 3 " is missing from an expression; the arrowheads in Figs. 4.13 and 4.14 are inconsistent and there are four unwanted square root signs on page 136. The sections dealing with R-C oscillators, rectifier filters and electric machines—apart from the three-phase induction motor—are too vague to be of much assistance to a student; and it would probably have been better if most of the elementary material had been omitted and more space devoted to fuller explanations of some of the more difficult parts of the subject.

This volume is, however, attractively produced at a reasonable price and possesses so many good features that it is hoped the authors will soon bring out a new edition with the typographical and other errors removed and faulty diagrams corrected.—E.H.

Mathematical Programming and Electrical Networks. By J. B. Dennis. Pp. 186. Illustrated. The Technology Press of Massachusetts Institute of Technology, John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., 37, Essex Street, London, W.C.2. Price 36s.

This book is a research monograph and its theme is that certain linear programming problems can be solved by setting up an equivalent electrical network containing voltage sources, current sources, ideal diodes, and ideal transformers. If the values of voltage and current are set to correspond to the data of the programming problem the optimal solution is obtained simply by measuring currents and voltages at appropriate points in the network. The value of the method described in this book is that the electrical analysis provides a physical model of mathematical programming problems as a set of conditions which must be satisfied rather than the usual geometrical picture of minimising a function over a constraint set.

The subject is dealt with in chapters covering such matters as mathematical programming, the nature of programming problems, properties and equivalent formulations of electrical networks containing diodes, an algorithm for solving electrical models of network flow problems, a breakpoint tracing procedure, breakpoint tracing methods for general linear and quadratic programmes, and an application of quadratic programming to the general programming problem. There is also a number of appendices of related features of the subject.

From the author's investigation the principal points which emerge are that the solution of any electrical network constructed of the four types of elements mentioned above is equivalent to determining the optimal solution of a linear programme while, vice versa, any linear programme problem can be modelled by an electrical network composed of the elements cited; also the addition of linear resistors to the network provides a more general equivalence between quadratic problems with linear constraints and electrical networks, and the electrical analogy permits a new interpretation of algorithms for obtaining solutions of programming problems and suggests new techniques. Finally, the breakpoint tracing scheme developed in the book is applicable to the solution of general linear and quadratic programmes.

All of these matters, as well as others in the book, are of considerable interest to mathematical programmers and electrical engineers concerned with network theory, and it is for them that this work should have particular appeal and stimulation.—A.E.

BOOKS RECEIVED

The Elements of Determinants, Matrices and Tensors for Engineers. By S. Austen Stigant. Pp. 433; figs. Macdonald & Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 60s.

Electro-Technology for National Certificate Courses. Vol. III. By H. Buckingham and E. M. Price. Pp. 361; figs. 295. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 16s.

Progress in Nuclear Energy. Series XI—Plasma Physics and Thermonuclear Research. Vol. I. Edited by C. Longmire, J. L. Tuck and W. B. Thompson. Pp. 612; figs. Pergamon Press, Ltd., 4 & 5, Fitzroy Square, London, W.1. Price 105s.

Letter to the Editor

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Low-Pressure Resins

IN the 4th December issue of your journal you report on pages 799-801 a summary of the paper by Manley *et al.*, read before the Institution of Electrical Engineers on 26th November, and of the discussion that followed.

I wish to call your attention to the fact that I have been misreported. I stated that we found it uneconomic to use epoxy castings for voltages *below* 33 kV, not above 33 kV as reported. Furthermore, my company does not manufacture switchgear. Finally, I would like to point out that I did not state that my company manufactured only simple symmetrical shapes. I said that contraction problems are made easier with solids of rotational symmetry.

Southampton. (DR.) F. J. MIRANDA.

VIEWS on the NEWS

By REFLECTOR

IT was once said of the Chicago pork packers that they canned everything but the squeak. Modern American science seems to be on the point of doing something even with this. A "small electronics firm" in Florida is reported to have devised means of generating electricity from noise. The head of the firm says:—

> "The device, called a phono-power element, could convert car noises to furnish enough power to handle lights, air conditioning—everything your car uses except the power to start it."

But this is only a start: the firm claims that it could produce enough power to light a city by placing a "noise-maker" in a soundproof room and "harnessing electricity through the phono-power unit." There's probably enough noise in London to enable at least one conventional power station to be dispensed with.

* * *

Nobody enjoys paying bills, but few people refuse to meet their just dues. Some of these few live in the Manchester area and they were discussed at a recent meeting of the North Western Electricity Consultative Council. According to the *Evening Chronicle*, members were told that supplies to 600 of the city's 45,000 consumers had to be cut off every month because they would not pay up. This implies that it is the same 600 (a sort of anti-light brigade) who are constantly on and off the system and apparently it is so. Worse still, it seems that heredity comes into it too for the chairman of the Council (Mr. F. Kenyon), after saying that "the history of many of the non-payers goes back to the days when electricity was handled by Manchester Corporation," went on:—

> "The same people who refuse to pay now refused to pay then. It seems to run in the family."

Presumably, the Electricity Board cannot refuse to re-connect after cutting off the supply and possibly isn't too much worried if it is able to recoup the cost and the arrears.

* * *

Usually it is contended that the Electricity Boards spend too much on publicity, an idea based on the false premise that electricity supply is a monopoly when in fact it is only one agent for the provision of heat and power. Somewhat strangely, one member of the East Midlands Electricity Consultative Council, the chief electrical engineer of the Players tobacco concern, expressed the view that the East Midlands Board was spending far too little this way—last year it amounted to only about £57,000 on a turnover of £42 million. Mr. N. F. Marsh, the Board's chairman, thought that enough was being expended on publicity for a nationalised industry did not need to advertise so extensively as some commercial firms. He said, as reported by the *Nottinghamshire Guardian Weekly*, that they did not want to start "a first-class advertising battle with the Gas Board." I still think that electricity has to keep its end up with gas. The question is: What is the Gas Board doing in the way of "promotion"?

* * *

The *Irish Independent* reports that the Lisnaskea Rural Council, having decided to build eleven houses, has found that a transformer belonging to the Electricity Supply Board is in the way and so it can only build ten. The Board has agreed to move the transformer to another site if the Council meets half of the cost. The matter was discussed at a recent meeting when the Council

> "decided to proceed with plans to erect 14 houses, postponing a decision on the E.S.B. letter."

* * *

An item in the *A.E.U. Journal* for November, from one of the Scottish divisions of the Union, reads as follows:

> "British Electricity Authority.—Dewar Place. The question of the Electrician being appointed work as a Fitter has now been resolved by the removal of the employee concerned to electrical work."

And to the South of Scotland Electricity Board, I hope.

* * *

I am accustomed to seeing complaints in the newspapers about low voltage and cuts in electricity supply. Usually they are of brief duration, but the Press makes the most of them. Conditions are certainly better than they were when a reader sent the following letter to the *Electrical Review* (15th December, 1909):—

> "I think I have read strong remarks in the *Electrical Review* anent the pressure at which the City Electric Light Co. at times supplies its consumers with light (?), but, at any rate, that company generally leaves you the hope-inspiring red hairpin as a promise of better times coming. To the unfortunate dwellers within the area supplied by the Metropolitan Electric Supply Company things are not so pleasant. There, for over a year, we have got so used to our red hairpin during the hours of maximum demand, that the company, evidently fearing lest we should become boastful, and look upon it as our right, have taken to cutting off the current altogether at these times. As witness last Thursday, light cut off from 6.45 to 8.15 p.m., Saturday, 4.15 to 9.45, Monday, 4.30 to 9.45, and now comes enclosed notice which informs us that we are to have no more evening light till next Thursday, 'by order of the secretary.' Having had some experience of central station work, I can make every allowance for unavoidable failures, but not when they are caused by months of overloading their plant, and then getting over the 'peak' difficulty by promptly cutting off the supply."

* * *

With the approach of the festive season I would like once again to wish all my readers a happy Christmas and prosperous New Year and to thank those who have passed on to me interesting items concerning the industry for inclusion in these notes.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The Minister of Power has re-appointed **Mr. D. Bellamy,** C.B.E., as chairman of the Yorkshire Electricity Board, **Mr. W. S. Lewis,** C.B.E., J.P., as chairman of the Midlands Electricity Board, **Mr. H. G. Partridge,** M.A., J.P., of Cardigan, as a part-time member of the South Wales Electricity Board, and **Mr. B. Pickup,** C.B.E., J.P., of Gatley, Ches., as a part-time member of the North Western Electricity Board.

Mr. D. N. Steeley has been appointed sales manager of standard industrial motors at the G.E.C. Engineering Works, Birmingham. Mr. Steeley was educated at Repton and joined the General Electric Co. as a student apprentice in 1949. After service in the Royal Navy he returned to the company as an assistant branch engineer in London.

Mr. D. N. Steeley

Dr. Ing. G. Macfarlane, B.Sc., A.M.I.E.E., a deputy chief scientific officer at the Royal Radar Establishment, Malvern, has been appointed deputy director of the National Physical Laboratory. He succeeds **Mr. E. Lee,** Ph.D., who becomes director of stations and industry divisions at the Department's headquarters, and will take up his new duties on 1st January.

Dr. Macfarlane graduated with first class honours in electrical engineering at Glasgow University in 1937, and went on to do two years' post-graduate research at Dresden, where he gained the Dr.Ing. degree in 1939. He joined the Telecommunications Research Establishment (now incorporated in R.R.E.) in 1939. Throughout the war years he concentrated on mathematics problems in radar and microwave physics. In 1945 he became head of the Mathematics Group, and a year later took charge of the Theoretical Physics Division. Since 1953 he has been carrying out individual research in the Physics Department. He is a Fellow of the Physical Society.

Dr. Lee was educated at Consett Grammar School and graduated at Manchester University with first class honours in physics. After graduating M.Sc. at Manchester University and Ph.D. at Cambridge University, he joined the Royal Naval Scientific Service in 1939 and was posted to the Admiralty Research Laboratory. In 1946 Dr. Lee joined the Defence Research Policy Staff at the Ministry of Defence. He was then director of operational research at the Admiralty for three years before becoming deputy director at the National Physical Laboratory in 1958.

Mr. H. P. Sale has been appointed sales manager (accessories division) of the Midland Electric Manufacturing Co., Ltd. Mr. Sale, who was formerly sales manager of M.K. Electric, Ltd., commenced his new duties with M.E.M. on 23rd November.

Associated Electrical Industries, Ltd., has appointed **Mr. S. White** as chief press officer, and he has now taken up his post in the Central Information Department to co-ordinate the press side of the activities of the A.E.I. Group.

Mr. White joins A.E.I. after a brief spell as deputy director of public relations at the Ministry of Defence. Until July he was chief press officer to the United Kingdom Atomic Energy Authority, which he joined on its inception in 1954. Before this he was a press officer at the Ministry of Supply with special responsibilities for atomic energy. Earlier he had been press liaison officer with the Allied Commission, Austria. His journalistic experience includes fourteen years with the *Windsor, Slough and Eton Express.* During the war he was an R.A.F. intelligence officer.

Mr. R. Miles has been appointed a director of Franco Signs, Ltd. Among his other directorships he is chairman and managing director of Head, Wrightson & Co., Ltd.

Mr. B. G. Neden, Associate I.E.E., at present a senior assistant commercial engineer at the Fens Sub-Area of the Eastern Electricity Board at Milton Hall, has been appointed electricity service manager of the Cambridge branch. Mr. Neden received his training with the Beds., Cambs. & Hunts. Electricity Co. and was its resident manager at Huntingdon and St. Ives from 1939 to 1946. He was appointed manager at St. Neots in 1946 and in 1949 went to the Cambridge district as the commercial engineer. In 1953 he was appointed to the commercial staff of the Sub-Area.

Mr. B. G. Neden

At the annual meeting of the Glass Manufacturers' Federation held at the Hyde Park Hotel, London, on 1st December, **Mr. A. W. Clark,** managing director of Beatson, Clark & Co., Ltd., was elected president for the ensuing year, and **Mr. I. B. Throndsen,** managing director of Johnsen & Jorgensen (Trident), Ltd., was elected chairman.

Mr. W. J. Vine, F.I.E.S., has been appointed manager of the Lighting Advisory Department of the Export Division of Thorn Electrical Industries, Ltd. Mr. Vine joined the company soon after the war as senior lighting engineer in the Illuminating Engineering Department. He was later appointed to deal with specialised lighting problems. During his service with Thorn Electrical Industries he has served continuously on the Lighting Fitting Design Committee and also on a number of committees of the Illuminating Engineering Society.

Mr. W. J. Vine

A presentation, to commemorate an important stage in the equipping of Britain's first missile station took place at the Royal Air Force Station, North Coates, Lincs., recently, at a dinner given in the officers' mess by the military radar group of **Associated Electrical Industries, Ltd.,** Electronic Apparatus Division. The presentation consisted of a silver "waiter" bearing an engraving of the "head" of the A.E.I. "Sting-Ray" target-tracking and illuminating radar. It was made on behalf of the A.E.I. military radar group by Mr. V. M. Roberts, O.B.E., divisional commercial manager, and the gift was received by Wing Commander H. L. Derwent, A.F.C., Officer Commanding at North Coates.

Dr. N. F. Astbury, M.A., Sc.D., M.I.E.E., F.Inst.P., has been appointed director of research of the British Ceramic Research Association as from 1st January next.

The Dubilier Condenser Co. (1925), Ltd., announces that all matters relating to publicity are now dealt with by **Mr. S. T. Kendall,** who has succeeded **Mrs. D. K. Williams.**

The annual general meeting of the North Metropolitan Branch of the **Electrical Industries Benevolent Association** will be held at Northmet House, Southgate, N.14, on 21st January at 3 p.m. Nominations for officers should be submitted to the

hon. secretary, Mr. A. T. Durbridge, Electricity Offices, 40, Church Street, Enfield, Middlesex, not later than 14th January. The annual dinner-dance of the Branch will be held on 22nd April next at St. Albans. Particulars can be obtained from Mr. Durbridge.

Mr. P. W. Tucker, M.I.E.E., retired last week from the position of technical editor of the *Electrical Review* after thirty-four years' association with this journal. Mr. Tucker was born at Strood, Kent, and attended the Medway Technical College. His first connection with the industry was when he joined the Gillingham Corporation Electricity Department in 1911. He then went to the Great Yarmouth undertaking as mains engineer in 1913, staying there until 1925 (his service being broken by a period in the army during the 1914-18 war) when he joined the *Electrical Review* as technical sub-editor. Later, from 1947 to 1953, he had a roving commission as staff contributor during which time he became well known to hundreds of people in the electrical industry and in many other industries. He succeeded the late W. O. Fenwick as technical editor in 1953.

Mr. P. W. Tucker

We are sure that readers will join with his colleagues in wishing Mr. and Mrs. Tucker many years of happiness in retirement.

Mr. P. Ransom, B.Sc., recently joined the International Rectifier Co. (Gt. Britain), Ltd., as engineering manager. He was previously with Associated Electrical Industries, Ltd., in the semiconductor research laboratories at Rugby. He joined the A.E.I. group in 1945 and since 1954 he has been directly concerned with the development of power diodes.

Mr. P. Ransom

Miss Evelyn F. Corner, senior housecraft adviser, headquarters staff, London Electricity Board, has been appointed commercial staff instructor at the Board's training centre, Pratt Street, Camden Town, N.W.

Mr. P. Gotley has been recently appointed as general manager of Equipments & Services, Ltd., manufacturers of automatic electrical timing and control equipment.

Mr. J. H. Brindle has been appointed manager of the Publicity Department of Air Control Installations, Ltd., and will take up his new appointment on 1st January. He has been with the company for the past fourteen years, mainly in technical departments.

Mr. N. Roberts has been appointed sales manager of Thermalay, Ltd. He was previously the company's resident representative covering the north of England.

Mr. R. H. Vivian, B.Sc., A.M.I.E.E., has joined the Wireless Telephone Co., Ltd., as chief engineer. Mr. Vivian has had wide experience of transistor application and has designed several basic transistor circuits. For many years he was development engineer in charge of transistor investigations and applications with A. C. Cossor, Ltd. He joins the Wireless Telephone Co. from Associated Industrial Consultants, Ltd., with whom he has been since 1957.

Mr. R. H. Vivian

OBITUARY

Mr. Samuel Cameron Gibson, borough electrical engineer at Nuneaton from 1901 until he retired in 1940, has died at the age of eighty-five at his home in Surrey.

Mr. S. G. Stevens.—The death occurred on 11th December of Mr. Sidney George Stevens, B.Sc., a telephone cable engineer with Standard Telephones & Cables, Ltd.

WILLS

Major H. Richardson, O.B.E., M.C., chairman and managing director of the Metropolitan Electric Supply Co., Ltd., and other associated undertakings before nationalisation, who died on 13th September last, left £23,908 gross (£23,315 net).

Mr. J. A. Chalmers, managing director of Andrew Chalmers & Mitchell, Ltd., manufacturing electrical engineers, Glasgow, who died on 16th April last, left personal estate in England and Scotland valued at £37,150.

Mr. L. H. A. Carr, M.Sc.Tech., M.I.E.E., associated for thirty-five years with the Metropolitan-Vickers Electrical Co., Ltd., who died on 27th August last, left £5,291 gross (£4,237 net).

Mr. W. H. Grinsted, O.B.E., F.C.G.I., M.I.E.E., for nearly fifty years a senior technical executive with Siemens Edison Swan, Ltd., who died on 26th September last, left £11,890 gross (£11,686 net).

Mr. A. W. House, electrical engineer, of House & Son, Ltd., who died on 13th July last, left £23,559 gross (£23,429 net).

European Tariffs and Trade

IN discussions on the merits of the two trading groups into which Europe is now split, and on the possibilities for their closer association, too little attention is usually paid to basic economic facts. One reason is that a detailed analysis of the way in which the pattern of European trade will be affected by the operation of the Common Market and the European Free Trade Association requires information on thousands of different tariff items which has been difficult to obtain. With the gradual liberalisation of quotas under O.E.E.C., tariffs have become of prime importance.

The latest P.E.P. report (*Tariffs and Trade in Western Europe*, Allen & Unwin, 30s) is therefore most welcome and should facilitate a more sober assessment of the economic advantages and disadvantages to this country of the various proposals for overcoming the present unsatisfactory situation. The report, which is most attractively and clearly presented, consists mainly of a series of tables in which the tariffs of the twelve main industrial markets of Western Europe and the future external tariff of the Common Market—covering over 1,000 items of manufactures, materials and foodstuffs—are compared and related to U.K. imports of the same categories of goods analysed according to countries of origin.

Comment on these bare facts will probably be made in later P.E.P. reports. But it is already evident that as a high tariff country Britain will be giving greater advantages to other members of the E.F.T.A. than she receives in return, and that British industry will suffer as the low tariffs of the growing markets of Germany and the Benelux countries are raised to the future Common Market tariff level.

Another interesting point that emerges from the report is that over a wide field the present British tariff on manufactured goods is very close to the eventual Common Market tariff.

Thus in relation to tariff harmonisation the obstacles to closer association between this country and the Common Market are clearly less formidable than is sometimes suggested. But here the link with the low tariff countries of the E.F.T.A. could make the "bridge" with the Common Market more difficult to achieve.

The P.E.P. study also contains trade network tables which show that Britain's share of intra-European trade fell from 23·7 per cent in 1928 to 13·2 per cent in 1958. The decline in France's and Germany's shares was slighter, but the smaller countries have gained an increasing share. Nevertheless, the greatest scope for expanding trade should come from the reduction in the barriers round the bigger nations. This desirable growth in European trade could be seriously retarded if these countries remain separated, as at present, in different trading groups.

Reactor Equipment for Norway

CONTROL apparatus of British design and construction, known as a reactor transfer function analyser, has just been successfully installed in the boiling heavy water reactor at Halden in Norway. Supervision of this operation was carried out by Mr. J. B. Lakeman, of the Atomic Energy Establishment, Winfrith.

The equipment will enable the reactivity of the reactor to be sinusoidally modulated over a range of frequencies from 10 c/s to 0·002 c/s and will measure the phase and amplitude of the resulting neutron flux response to within 1° and 1 per cent respectively. It will be used to obtain data on the physics and dynamic behaviour of the reactor. A feature of the Halden installation is its ability to control the experiment from the reactor control room, involving remote gear changing and motor control over a distance of about 150 yd.

The equipment was designed at the Atomic Energy Research Establishment, Harwell, for the Halden reactor project. This reactor, moderated and cooled by heavy water, is situated near a woodpulp and paper plant, at Halden, 120 kilometres south of Oslo. It is the first boiling heavy water reactor in the world and the first boiling water reactor in Europe. Besides its main function as a demonstration reactor for studying problems associated with boiling heavy water reactor systems, the installation also produces some 15 tons per hour of process steam in a secondary light water circuit, to be used by the woodpulp and paper plant.

Lamp Production Machine

A MACHINE for making the "pinch seal" of an incandescent lamp, the basic manufacturing stage, has been developed by the Osram Lamp Works of the General Electric Co., Ltd., and is now undergoing production trials at a speed of 3,500 pinches per hour. A "pinch seal" contains four parts, a flanged glass tube, a hollow glass stem which is both an exhaust tube and filament support, and two lead wires with fuses. The filament of the lamp is subsequently mounted on to the assembly and finally sealed into the lamp bulb.

Normally, seals have been manufactured by using a turntable or turret which comes to rest at a succession of fixed positions where feeding devices, manipulating tools and heating burners are arranged. Modern machines of this type are limited to between 1,500 and 1,800 parts per hour by the stresses set up by frequent stopping and starting and inadequate rest periods for operations involving heating or cooling to be carried out. The new Osram machine rotates continuously. It has a turret with forty work heads, each equipped with its set of tools and burners. Five devices round the turret feed the components to the work heads and the completed pinch seal is removed by a small transfer turret. Machines are being developed for the subsequent operations of filament mounting, sealing in, gas filling, etc., to provide a complete manufacturing group based on the constant flow principle.

Osram "pinch sealing" machine

Fluorescent Lighting

A PAPER entitled "The Application of Phosphors in Lighting," by Mr. A. H. McKeag, was read at a meeting of the Illuminating Engineering Society held recently. Research on phosphors for use in the lighting field had been pursued continuously for a period of nearly 30 years. From a few phosphors based on known luminescent minerals, the present wide range of materials had been evolved for use in fluorescent tubes and colour corrected high pressure mercury vapour lamps.

Phosphors were crystalline inorganic luminescent materials of high purity, usually containing a small quantity of one or more foreign elements, known as activators. A suitable heat treatment, at a temperature which might be as high as 1,250°C, was necessary to promote crystallinity in these materials and to incorporate the activator in the resulting crystal lattice. The properties of a phosphor depended on the combination of a particular chemical matrix and a specific activator or activators. Although it was not yet possible to predict a potentially useful phosphor from purely theoretical considerations, solid state theory could explain, at least qualitatively, the effects observable in phosphors.

The paper then dealt in particular with the application of phosphors to fluorescent tubes and high pressure mercury vapour lamps. Developments in other forms of light sources incorporating phosphors, including electroluminescent lamps and lamps with radioactive krypton, were discussed.

Royal Society Conversazione

A RANGE of exhibits and demonstrations dealing with British scientific and technological developments was shown to Viscount Hailsham, the Lord Privy Seal and Minister for Science, and other Members of Parliament and representatives of scientific institutions and overseas organisations, at a conversazione held in London on 9th December by the Parliamentary and Scientific Committee. This Committee is an unofficial non-party group of members of both Houses of Parliament and representatives of scientific and technical institutions, established to provide a permanent liaison between scientific bodies and Parliament.

The exhibits included a model sponsored by the Electrical Research Association showing the application of electric floor-heating to a multi-storey block of flats, and a number arranged by the Institution of Electrical Engineers. Among these were a transistorised electrocardiograph provided by Philips Electrical, Ltd., a model of a reactor unit for Berkeley nuclear power station lent by the Central Electricity Generating Board and a low-speed computer provided by Ericsson Telephones, Ltd., which demonstrated the application of cold-cathode trigger tubes to sensing, storing and counting circuits.

Two of the displays sponsored by the British Institution of Radio Engineers were a Marconi mobile colour television unit and a Racal Engineering radio receiver having continuous tuning over the 1 to 30 Mc/s band. This was shown operating with a unit with a cathode-ray tube on which portions of the radio frequency spectrum up to 1 Mc/s in width could be displayed, the frequency of any signals received being indicated by vertical "pips" from the horizontal timebase sweep.

INDUSTRIAL NEWS

Electricity Supply Wages

A meeting of shop stewards of the manual workers' unions with members in the electricity supply industry was held in Birmingham on 12th December. They discussed the next move in relation to the claims for a 40-hour week and a minimum weekly wage of £10 following the recent 24-hour token stoppage at several power stations.

It was decided to call a meeting of delegates for 23rd January to decide upon action to reinforce the claims.

The unofficial ban on overtime by power station workers ended on 11th December when the men at Brunswick Wharf power station, Poplar, the only London station still operating the ban, decided to resume normal working. A spokesman of the unofficial shop stewards' committee which called for the ban last month said that normal working would continue until after the negotiations on the claims for shorter hours and higher wages were resumed. It depended on the outcome of that meeting whether there would be a resumption of unofficial action.

Engineering Workers' Claims

At a special conference at York on 10th December the Confederation of Shipbuilding and Engineering Unions decided to reiterate its claim for the institution of a 40-hour week and an increase of £1 a week in wages. Both claims were recently rejected by the employers who, however, offered a 42½-hour week.

It appears that the Confederation's negotiators were given power to arrive at a settlement with the Employers' Federation if a satisfactory offer is made. Failing this the Confederation will again be consulted.

The Hunterston Dispute

One of the six trade unions involved in the dispute with the Motherwell Bridge & Engineering Co. at Hunterston, Ayrshire, nuclear power station site has come to terms with the company. It is the Constructional Engineering Union, which agreed last week to accept the company's wage structure proposals.

Export Service Bulletin

From 1st January the Board of Trade is to publish a new *Export Service Bulletin*. It will appear on Mondays, Wednesdays and Fridays and will contain all the urgent information about overseas calls for tenders and export opportunities at present published as individual circulars in the Special Register Information Service. This will be discontinued in its present form. In addition, on every Monday, a weekly supplement will also be published which will contain the latest economic and market commodity reports received from the United Kingdom Commercial Diplomatic and Trade Commissioner Services overseas. All the information available will be sent to every subscriber. Careful attention has been given to layout to make the new *Bulletin* easy to read, and so that every subscriber may be able to pick out the items in which he is interested in the minimum of time.

An annual subscription of £10 10s, including postage, will be charged for the *Export Service Bulletin* (additional subscriptions to the same address, £5 5s per copy, post paid). It will, however, be supplied to existing subscribers to the Special Register Information Service until the date of termination of their current subscription, without extra charge.

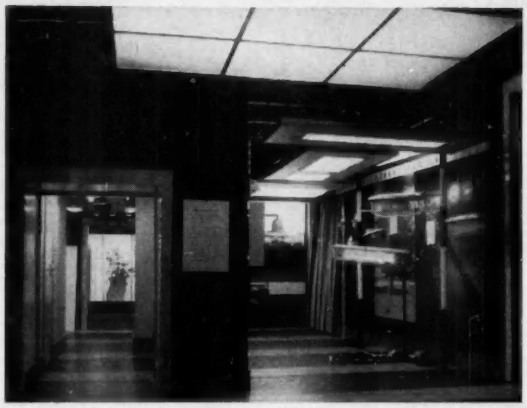
Factory Inspectorate Directory

The Ministry of Labour has published "H.M. Factory Inspectorate Directory" (H.M. Stationery Office, 3s net) which gives information about the divisions and districts of the Factory Inspectorate in Great Britain. This new publication arises from the reorganisation and renaming of the divisions which came into force on 3rd March last year. It is intended as a handy ready reference book for all those in industry who seek advice or information concerning matters which come within the jurisdiction of the Factory Inspectorate.

In an explanatory note the booklet states that for the purposes of the organisation of the Inspectorate Great Britain is divided into twelve English divisions, Scotland and Wales (with Monmouthshire). Details are given of the area covered by each district in a division, together with the address and telephone number of the divisional and district offices.

Crown House Showroom Extended

On Monday last an extension of the showroom of the A.E.I. Lamp & Lighting Co., Ltd., was opened; it increases the floor space by about 1,000 sq ft, raising the total area to 3,250 sq ft. At the moment the new "wing" is being used for the display of industrial and commercial lighting while the main showroom is occupied chiefly by domestic fittings.



The new extension of the Crown House showroom

Among the exhibits is a section of "Isora" ceiling fabric, a light translucent plastic material in various colours which is secured in a galvanised mild steel framework to form panels. Other items on show include waterproof and flameproof industrial fittings; street-lighting lanterns and lamps, including the new "Mazda" 200 W sodium linear lamp; floodlighting equipment; and shop and display fittings.

B.E.A.M.A. Export Sales Conference

The Domestic Appliance Division of B.E.A.M.A. is holding a one-day export sales conference on 10th February next under the title "Re-arm for Export." The speakers will include the President of the Board of Trade, Mr. Reginald Maudling, Lord Chandos and Sir Leslie Gamage. The conference chairman will be Mr. Stanley Broughton, managing director of Electrolux, Ltd.

Chloride's Forty-Hour Week

A paragraph in the December issue of the *Journal* of the Amalgamated Engineering Union stated that agreement had been reached with Chloride Batteries, Ltd., for the establishment of the 40-hour week without loss of pay. It was said that "this involves a 6½d per hour increase, and establishes a new total rate for normal hours of 6s 9½d. Overtime payments will continue as previously." Another concession is that four weeks' notice is to be given of "redundancy" to men with more than one year's service.

Chloride Batteries, Ltd., tell us that this statement is not strictly correct in detail. The agreement is that actual working hours shall be reduced from

42 hours 5 minutes to 40 per week. The previous nominal working week of 43¾ hours included a paid tea-break of 20 minutes each day. This is to be abolished. To provide for the reduction in hours without loss of pay, an allowance of 6½d an hour will be paid for all hours worked, up to a maximum of 40 in any week. It is emphasised that this is in the form of an allowance and is not an increase in the rate. The company says that the statement regarding four weeks' notice is correct and that the agreements begin to operate from the commencement of the first pay week in January. Negotiations are taking place with other unions concerned.

Purchase Tax Notice

The Commissioners of Customs and Excise have issued Notice No. 78 (November, 1959), setting out in full the classes of goods subject to purchase tax, with notes on the application of the tax. This supersedes Notices No. 78 (October, 1958) and 78P (April, 1959).

Purchasing as an Aid to Productivity

A conference, organised by the Willesden and Hendon Productivity Committee, will be held at the headquarters of the F.B.I. at 21, Tothill Street, Westminster, S.W.1, on 27th January next. The admission fee will be two guineas and applications should be sent to Mr. D. I. Duncan, A.E.I. Switchgear Division, 20, Neasden Lane, Willesden, N.W.10.

Computer Centre Opened

A new showroom and computer centre for De La Rue Bull Machines, Ltd., was officially opened at 114-118, Southampton Row, London, on 9th December by Sir Christopher Hinton, chairman of the Central Electricity Generating Board. Other speakers at the ceremony included the chairman of the new company, Mr. A. G. Norman, the French Ambassador, M. G. Shauvel, and M. P. Dreyfus of the French concern. The company was formed by the De La Rue Co., Ltd., to market in Britain and the Commonwealth the range of punched card and computer data processing equipment made in France by the Compagnie des Machines Bull of Paris. These include the "Gamma 3" and "3B" computers which use magnetic drum memory storage and the latest "Gamma 60" model which has magnetic core storage elements and is capable of 100,000 operations per second. Over 700 Gamma computers are now in operation in 25 countries. The new building in London houses a service engineers' workshop, a car park with turn-table and lift, a 1,700 sq ft showroom and three floors of offices.

West German Industrialists' Visit

The West German industrialists and professional men who recently made a tour of the British electronic computer industry were impressed by United Kingdom development and expect that there will be substantial sales of equipment to West Germany over the next few years. In a statement the mission said they considered that British computers were competitive in the German market both as regards quality and price, and the visit had been extremely successful. The British electronic industry had made advances in the field which were far from widely known in Western Germany, and had a wide range of equipment to offer. The visit was organised by the Joint Committee of the Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association under the chairmanship of Mr. V. M. Roberts, O.B.E., with the co-operation of the Board of Trade and the British Embassy in Bonn. The programme included visits to Ferranti, Ltd.; English Electric Co., Ltd.; E.M.I. Electronics, Ltd.; Standard Telephones & Cables, Ltd.; International Computers & Tabulators, Ltd.; Associated Electrical Industries, Ltd.; Elliott Bros. (London), Ltd.; and the National Cash Register Co., Ltd.

The showroom at the new computer centre of De La Rue Bull Machines, Ltd.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £180 0s 0d
COPPER, H.C. Electro	ton £253 10s 0d
Fire Refined 99·70%	ton £252 0s 0d
Fire Refined 99·50%	ton £251 0s 0d
COPPER Tubes ..	lb 2s 5½d
Sheet	ton £286 15s 0d
H.C. wire and strip	ton £310 15s 0d
LEAD, English ..	ton £71 15s 0d
Foreign	ton £70 0s 0d
MERCURY	flask £71 10s 0d
TIN, block (English) ..	ton £788 10s 0d
ZINC, G.O.B. Foreign	ton £95 15s 0d
BRASS Tubes (solid drawn)	lb 2s 0½d
Wire	lb 2s 10½d
PHOSPHORBRONZE Wire	lb 4s 3½d
PLATINUM ..	oz £28 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 34½d—34⅞d

Electrical School for Children

A campaign to promote the efficient use of electricity in the home has been launched by Edmundsons Electrical Wholesalers, Ltd., by the opening on 15th December of the first "Summit" electrical school for children at Marshall & Snelgrove, Ltd., Oxford Street, London, W.1. Mr. E. Frais, speciality sales manager for Edmundsons, says that with the increasing use of electricity in the home it becomes more and more important that children should have an understanding of how electricity works, how to use and care for domestic electrical appliances and how to avoid accidents through careless use of them. The company is organising these schools in various centres around the country. At each there will be experts in attendance who will give the children a brief talk, show them how the various appliances work and answer questions. The school at Marshall & Snelgrove's will be held twice daily (11 a.m. and 3 p.m.) until 28th January, and the company's first "Summit" kitchen will be on view. This has been designed by Mr. J. Prizeman, A.A.Dipl., A.R.I.B.A., and incorporates a number of new ideas in kitchen design. Further schools will be held in the New Year at Edwin Jones, Ltd., Southampton, Lowe & Oliver, Ltd., Oxford, and at other centres.

Lighting for Printing

A new and completely restyled edition of "Lighting for Printing," which the printing industry has for some years regarded as the authority on the subject, has been published by the British Lighting Council, 16-18, Lancaster Place, London, W.C.2. It covers every aspect of lighting in the

printing industry from general requirements to specific needs of each process, and from the advantages to be gained from the colour properties of certain lamps, to the productive value of good lighting which is carefully maintained. Several appendices contain such useful information as recommended minimum lighting levels for all stages of the industry, and performance figures of appropriate sized fluorescent lamps. The price of the booklet is 1s 6d per single copy and £5 10s per hundred, post free.

C.E.G.B. Leatherhead Laboratories

Humphreys, Ltd., have been awarded a contract valued at £834,500 to build laboratories at Leatherhead for the Central Electricity Generating Board, Southern Project Group. The laboratories are designed for general research into materials used for the generation of electricity and insulation. They will consist of a main central block and two wing blocks. There will also be a canteen building, a separate lecture theatre and other ancillary buildings. The architects are Messrs. Clifford, Tee & Gale.

Electrical Exports by Air

During the first half of 1959 £7·8 million worth of electrical goods were exported by air from this country. This was 7 per cent of total electrical exports during the six months and compared with £5·6 million, or 5 per cent of the total, in the first half of 1958. Electrical goods accounted for 12 per cent of total U.K. exports by air.

Electrical goods imported by air during the period January-June, 1959, amounted to £6·2 million, or 34 per cent of total electrical imports. This compared with £4·3 million, or 31 per cent of the total in the first half of last year. Of the £2·1 million worth of electrical goods re-exported 57 per cent went by air.

Veritys Revived

In our issue of 18th September last (p. 294) we reported the purchase by William McGeoch & Co., Ltd., in conjunction with F. & C. Osler, Ltd., from the liquidator of Veritys, Ltd., of Veritys (Maxlume), Ltd., and Veritys (Switchgear), Ltd., which had been formed to acquire the Maxlume and Switch and Control Gear Departments and the portion of Veritys works at Aston, Birmingham, previously housing these departments. Veritys were one of the oldest electrical concerns in this country, and under the titles of the new companies the name has been granted a new lease of life. At the Aston factory many established Verity products are once more being manufactured, and, in addition, plans are well in hand for the transfer to the Maxlume works of Osler's plant and employees from the Broad Street premises, which are to close under Birmingham's re-development scheme.

At a Press gathering in London last week, Mr. W. Percy McGeoch, who is chairman of both companies, in a speech of welcome briefly referred to some of the products which are being made, and there was a display of typical products, including industrial and decorative lighting fittings. A well-produced catalogue has been issued covering floodlighting equipment, flameproof fittings, weatherproof fittings, fluorescent lighting equipment, switchgear and control gear.

A sheet metal working shop at the Aston factory of Veritys (Maxlume), Ltd., and Veritys (Switchgear), Ltd.

Works Visit

During a sales conference of W. C. Holmes & Co., Ltd., held at the end of November and attended by sales engineers from all parts of the country, a day was set aside for a visit to the Bushbury Works of the Electric Construction Co., Ltd., which designs and manufactures electrical equipment used with "Holmes-Elex" electrical precipitators and "Trion" electronic air filters. The party, which was led by Mr. B. J. Duncan (field sales manager) and Mr. M. D. Auchterlonie (Birmingham office manager), was met by Mr. J. D. Noble (technical manager —rectifier/electronics) and members of his staff, and later met Mr. J. C. Milne, managing director of the Electric Construction Co.

Equipment for Car Ferry

W. H. Allen, Sons & Co., Ltd., Bedford, have received instructions from Philip & Son, Ltd., Dartmouth, to provide the equipment for the propulsion of a new car ferry. This will be a diesel-electric installation consisting of two engine-driven units (one being a standby) and two motors, each driving a paddle-wheel through a reduction gear. Control of direction and speed will be in the driver's cab acting on the main generator.

TV Traffic Control

Closed circuit television is being used at West Drayton, Middx., to assist police in traffic control while road widening is in progress. The television system has been specially designed by E.M.I. Electronics, Ltd., and enables one policeman to control four busy traffic lanes.

E.D.A. Public Speaking Competition

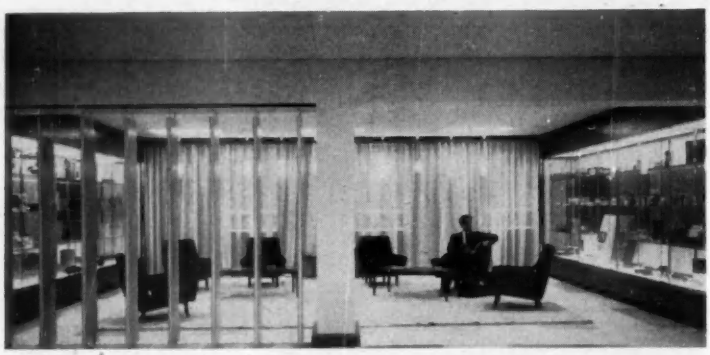
The subjects chosen for the 1960 E.D.A. Public Speaking Competition are "Up-to-date Gardening," "Electricity and Health" and "The Case for the All-Electric Home." In addition, should none of these appeal, a free subject may be chosen, the only stipulation being that it must have a clear connection with electricity supply or utilisation. Electricity Boards will soon be starting to hold their area competitions, the various winners going through to the national finals, which will be held in London during May. Competitors must be employees of the electricity supply industry and must be under thirty-five years of age.

Holiday Arrangements

The works of British Insulated Callender's Cables, Ltd., will be closed for the Christmas and New Year holidays as follows:—Prescot, 25th to 27th December and 1st to 3rd January; Huyton Quarry and Melling Works, 24th to 27th December and 1st to 3rd January; Anchor Works, Leigh, 24th to 27th December and 1st to 3rd January; Erith and Helsby Works, 25th to 28th December.

Nuclear Conference Report

The first volume of the proceedings of the conference on industrial prospects in nuclear energy, which was organised by the European Nuclear Energy Agency in Stresa last May, has been published by the O.E.E.C. under the general title "The Industrial Challenge of Nuclear Energy" (price 18s 6d). This volume covers the sessions devoted to surveying the European nuclear programmes, the economics of nuclear power and the



View of the well-lighted entrance hall of the Reed Paper Group Packaging Division's new Brentford headquarters in which a wide range of the Division's products is displayed

financing of the programmes. The two special studies, "Estimates of Nuclear Energy Production in Europe 1958-65" and "Financing Nuclear Energy Programmes and Relations between State and Industry," have been revised in the light of the conference findings.

Sugar Machinery for Formosa

The first ten of sixty sets of controls for sugar centrifugals destined for the Far East recently left the Bedford works of Brookhirst Igranic, a Metal Industries Group company. They were dispatched to Thomas Broadbent & Sons, Huddersfield, who are manufacturing the machines for shipment to Formosa, where the sugar industry is being re-equipped.

Educational

Particulars are announced in our advertisement pages today of a course of ten lectures on "Recent Developments in Magnetic Materials and their Applications" at the Northampton College of Advanced Technology, London, E.C.1, commencing on 19th January.

Reed Packaging Division Headquarters

The Reed Paper Group's Packaging Division has now occupied its new headquarters, Reed House, Kew Bridge, Brentford, Middlesex, thus for the first time bringing together as one functional unit all the companies with interests in the packaging field. These are Reed Corrugated Cases, Ltd., Reed Cartons, Ltd., and Metway Paper Sacks, Ltd., which between them embrace virtually the entire range of paper, paper board and fibreboard packaging.

The Division was created earlier this year as a rationalisation of the Group's extensive packaging interests, the principal objective being to increase and strengthen further the packaging service which the parent company, Albert E. Reed & Co., Ltd., has developed, and to provide a comprehensive packaging service to industry based on existing manufacturing facilities. Heating throughout the new building is provided by non-withdrawable electric cables embedded within the floor and thermostatically controlled. The electrical installation comprises steel trunking fixed to the ceilings, which carries both the cables and fluorescent light fittings, while the more important offices have been fitted with acoustic ceilings to serve the dual purpose of masking the electrical trunking and affording a high degree of sound insulation. Telephone cables, wiring to power points, etc., distributed throughout the offices, are installed in Key Engineering skirting trunking.

Calendars and Diaries

We have received from Riley & Neate, Ltd., Winchester, a neat pocket diary bound in red leatherette, which, in addition to diary space, contains 160 pages of technical data, some pages of squared paper and a number of sectional maps of the British Isles.

The calendar of Courtney, Pope (Electrical), Ltd., has an attractive picture of a young lady in a sun suit with her white poodle. The monthly slips of the calendar show also the preceding and following months.

A colourful picture of an 18th century ball surmounts the calendar received from Kent Bros. Electric Wire Co. & E. H. Phillips, Ltd., which has monthly slips showing also the preceding and following months.

A charming picture of a lady holding a kitten has been selected by the Midland Electric Manufacturing Co., Ltd., for its calendar which has monthly slips, showing also the preceding and following months.

A useful engagements calendar has been received from Edwards High Vacuum, Ltd. The weekly slips show the preceding and following months.

Pictures of scenes from all the five continents surmount the wall calendar received from Danfoss. It has large sheets, each showing the current and succeeding months.

The pocket diary received from A. Reyrolle & Co., Ltd., is bound in navy blue soft leather. It includes the addresses and the names of the managers of the various branch offices of the company in this country, and addresses of branches and agents and distributors overseas. There are also a number of useful sectional maps of the British Isles.

A useful engagements calendar has been received from E.M.F. (Electrical), Ltd.

Change of Name

The City Engineering Co. (Boreham Wood), Ltd., has decided to change its name to Citenco, Ltd. The company's address is still at Manor Way, Boreham Wood, Herts.

Trade Announcements

The Bristol branch of **Wolf Electric Tools, Ltd.,** has moved to new and larger premises at 1 to 3, Dean Street, Bristol, 2 (telephone: Bristol 22288).

Electro Methods, Ltd., has moved its Electrical Connector Division to new premises at Hitchin Street, Biggleswade (telephone: Biggleswade 2086). The divisional manager is Mr. D. P. Wright.

Wheeler Electrical Supplies (Wholesale), Ltd., are opening a new branch at 1, St. Mary's Street, Ilkeston (telephone: Ilkeston 3630), under the management of Mr. V. F. Sewell.

A new company, **Vallance Electrical Engineers, Ltd.,** has been founded to take over the electrical contracting department of Vallance & Davison, Ltd., and the business has been transferred to Gathorne House, Roundhay Road, Leeds, 8. The directors are Mr. M. B. Vallance and Mr. W. Hall, who was formerly Vallance & Davison's electrical contracting manager, and started the department fifteen years ago.

The factory extensions of **Electroway Heaters, Ltd.,** Loughborough, who manufacture electric heating appliances and commercial catering equipment, will be completed in January next, and will include a new conveyor enamelling and handling plant, and main assembly of appliances and catering equipment. Additions to the offices will include showrooms and a demonstration theatre.

The Electrical Appliance Division of **Allied Ironfounders, Ltd.,** is now at 30, Orchard Street, London, W.1 (telephone: Mayfair 8454), to which all sales and service inquiries should be sent. The sales manager of the division is Mr. A. L. Bass. Showrooms and other departments of Allied Ironfounders remain at 28, Brook Street, London, W.1.

Mr. H. C. Grant has been appointed sales representative for Scotland for **S. O. Bowker, Ltd.** He was previously with Black & Decker, Ltd., and E.M.E. Products of Edinburgh.

The head office of **Tricity Cookers, Ltd.,** has been moved to Thorn House, Upper St. Martin's Lane, London, W.C.2.

Alternator Field Suppression

Summary of a paper entitled "Field Suppression of Turbo-Alternators" by J. R. Hill, B.Sc.(Eng.), A.M.I.E.E., A. Hunt, B.Sc.(Eng.), A.M.I.E.E., W. J. Joyce, B.Sc., A.M.I.E.E., and D. H. Tompsett, B.Sc.(Eng.), A.M.I.E.E. (English Electric Co., Ltd.), which was read before the I.E.E. Supply Section of the Institution of Electrical Engineers on 9th December

THE purpose of field suppression is to remove the field of the alternator and to dissipate the stored magnetic energy. The arrangement most commonly adopted in this country is by connecting a resistance across the rotor slip rings whilst disconnecting the exciter by opening the field circuit-breaker. The main requirements are the rapid transference of rotor current from the exciter circuit to the discharge resistor with a rapid decay of current on the discharge resistor circuit, and the limitation of the voltage across the rotor winding to a safe value. A compromise between these requirements has to be made.

When a fault occurs on the alternator, stator currents several times greater than normal are induced on the field, as shown in Fig. 1, which is for the case of a three-phase fault with the alternator previously at normal voltage on open circuit. The paper gives expressions for the rotor current (containing transient d.c. components having the alternator transient and sub-transient time constants and a transient a.c. component with the armature time constant), the breaker arcing time, the peak rotor voltage and a function representing the fault damage, and considers the influence of various parameters on these quantities. Comparison with test results indicates that inaccuracies occur due to neglecting saturation and to some simplifying approximations.

The rotor voltage is the product of the discharge resistance and the resistor current. At the instant of clearance the circuit-breaker must develop an arc voltage equal to the rotor voltage plus the exciter voltage. Normally the circuit-breaker interrupts at a trough of the current wave and the peak rotor voltage then occurs at the next peak value of rotor current.

After circuit-breaker interruption, the rotor current decays with a time constant approximately $\frac{\tau'd}{K+1}$ where K is the ratio of discharge resistance to hot field winding resistance and $\tau'd$ is the transient time constant. The use of a high value of discharge resistance would apparently give a more rapid decay of field current, but in practice this not so as the breaker arcs for a longer period, giving an effectively lower resistance. Also, a high discharge resistance may give excessive rotor voltages unless limited by the maximum arc voltage of the circuit-breaker.

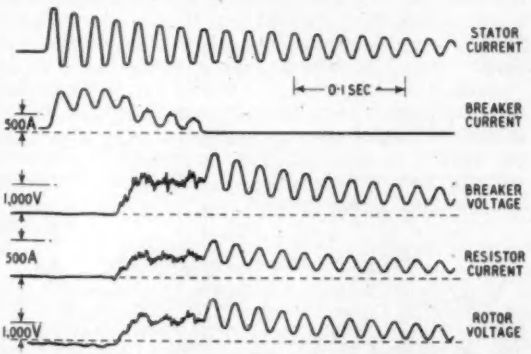


Fig. 1.—Oscillogram of field-suppression test on turbo-alternator when short-circuited

The desirability of limiting the rotor voltage to 3 kV and the breaker arcing time to 0·06 sec usually results in a value of K=1·5 to 1 for machines of 100 MVA to 300 MVA.

Stator Damage

To enable a comparison of the efficiency of field suppression to be made, it is assumed that the fault damage is proportional to the energy fed into the fault, which is in turn proportional to the time integral of the fault current.

Energy is supplied to the fault from the system and from the alternator before and during field suppression. It is only the energy supplied during suppression of the field which can be affected by varying the discharge resistance.

It appears that the damage is not greatly affected by values of K in excess of 2. With K decreasing between 2 and 1 there will be some increase in damage, but with large alternators this hazard must be accepted.

Testing the Field Circuit-Breaker

It is not practicable to test the circuit-breaker under actual working conditions and other methods of proving its suitability must be considered. It is only in the proving of the interrupting capability of the main contacts that the difficulty of synthesising a test circuit arises. A synthetic d.c. circuit that has been proposed is discussed. This circuit gives a current equal to the maximum value of the main d.c. field current at a test voltage equal to the product of this current and the discharge resistance. It is suggested that the circuit-breaker characteristics—rate of rise of arc voltage, maximum arc voltage and permissible arc duration—should be determined in a simple d.c. inductive test circuit. Then, by estimating the field suppression requirements, the suitability of the circuit-breaker can be judged.

Consideration is also given in the paper to other forms of field suppression which have been used. These are either similar and less efficient or more complex to give a greater efficiency.

DISCUSSION

Mr. L. W. James (C.E.G.B.), who opened the discussion, said that, as during the last few years the size of generator units had increased from 40-50 MW to 350 MW and upwards, the duty of field suppression equipment had increased tremendously. Experience of duties of this higher order was very limited, since large machines with directly-cooled rotors had been in commission for only a short time. Some trouble had been experienced with the field switches supplied with units of about 60 MW and the recent practice of the Board

had been to install switches in the exciter field circuit in addition, to trip at the same time as the main field switch. In general, where stator failures had occurred, the amount of core burning had been extremely small, suggesting that field suppression had been satisfactory. The authors said it was the usual practice to earth the generator through an impedance. It had been the general practice of the Board for some years to earth the neutral through a non-inductive resistance to give a current of 300 A when full phase voltage was applied. This followed a series of unfortunate failures. So far as the generator was concerned, it was desirable to kill the field as soon as possible, and in the 1951 specification for a 60 MW machine a discharge resistor with 4-5 times the cold rotor resistance had been recommended. This had later been used for ratings up to 200 MW, but another and later review suggested that 4-5 times was too high and, in 1955, it had been modified.

Practice in France

M. P. Laurent (Electricité de France) said that the authors' system, involving a discharge resistor and a field circuit-breaker, was essentially that used in France for water-wheel generators up to 30 MVA, the value of the discharge resistor being 4-5 times the hot field resistance. Since the war they had concentrated on two types of turbo-alternator, of 125 and 250 MW, and the next set would probably be 450 to 500 MW. For these big machines, whether hydraulic or thermal, the systems used by French manufacturers were all based on the common principle of reversing the exciter field until the alternator field current or flux reached extinction point. It was considered preferable to apply a constant back voltage to do the whole process of flux suppression, and its value could be made equal to the exciter ceiling voltage. They had had no experience of the damage which could result from insulation failures in turbo-alternators of over 100 MW, because they were always run in hydrogen and were too new to have given any insulation trouble.

Mr. D. A. Muret (G.E.C.), dealing with the choice of circuit-breaker, said the authors seemed to suggest that the synthetic test circuit was of little value and that it was too severe and might result in an over-designed breaker. They put forward an alternative approach in which, to obtain the arcing characteristics of the breaker, the rate of rise, ceiling voltage and so on, they would have to do a number of tests in a d.c. test plant the power of which was much the same as would be required for the synthetic test and analyse the results and extrapolate them to forecast how the breaker would perform. The factor of safety necessary to cover the guesswork in the last step would probably not be less than that incorporated in the breaker tested in the synthetic circuit.

Simplified Approach

Mr. C. Ayers (Kennedy & Donkin) put forward a simplified mathematical approach to the problem faced by the authors, which in essence provided that the maximum current was proportional to 1 divided by the short-circuit ratio times the transient reactance and that the maximum voltage was K times this maximum current. The theory had no mathematical logic behind it, but a comparison of its results with the authors' test figures showed a very good approximation, well within the 25 per cent accuracy which they claimed for their method.

Mr. P. T. Thornhill (A.E.I.) expressed surprise at the values of discharge resistance quoted in the paper, where for machines between 75 and 300 MVA values of 1-1½ times the hot field resistance were regarded as reasonable. The cost of outage of a 300 MVA set could be up to £500 per hour, so that it seemed desirable to have as high a value of discharge resistance as possible. His firm's practice was to have a value 2½-4 times that of the hot field and circuit-breakers were available which would deal with these higher voltages.

He considered that the synthetic test was better than that used by the authors for proving that a breaker was capable of dealing with a certain voltage and a certain current at the same time, similar to those which it would meet in practice. This sometimes necessitated taking the circuit-breaker abroad for testing, for lack of adequate facilities in this country.

Mr. P. D. Aylett (C.E.G.B.) said that coarse synchronising might be useful. This meant that the contacts should be designed for normal operation with substantial currents going through the discharge resistor. He thought the best solution was to dispense with the field discharge resistor and the field breaker. New types of high-speed voltage regulator were being developed which would do the reversal and suppress the field rapidly and obviate the need for a field breaker and field discharge resistor.

Mr. P. L. Olsen, referring to rotor troubles, did not think that the field suppression methods previously used had given any real trouble, nor could he remember any stator winding faults giving trouble. The field breaker must be specially designed for its purpose; it was wrong to adapt a standard article for the purpose. There should be no hazard in doing without a discharge resistor and his firm had until recently specified that field breakers must be capable of operation without it, relying on the arcing of the contacts and the dissipation circuits.

Mr. W. Fordham Cooper said there had been an increasing tendency to put small pieces of apparatus such as unit transformers direct on to the alternator terminals. If the field could not be suppressed quickly and the full short-circuit output of a large alternator was put on some small piece of apparatus not protected by a circuit-breaker it would be blown sky-high and the bigger the alternator the bigger the bang. It was time to reconsider this practice.

Core Damage

Mr. Hunt and Mr. Tompsett made brief replies. Mr. Hunt referred to damage to the core, which was obviously at the root of the problem, and said there was no firm information at present about the amount of damage which could be expected from fault currents of particular values. How far it was possible to go in reducing the discharge resistance must remain largely a matter of opinion because of uncertainty about the difference in damage from using a lower or higher value. The discharge resistance value would have to be kept as high as practicable without running into other troubles. It was interesting to find that European practice leaned heavily on using a resistor in series with the rotor circuit together with reversal of the exciter voltage, and this method of suppression deserved more attention than it had so far received in this country.

High-Voltage Insulators

In reporting the discussion on Dr. J. S. Forrest's paper on "Research on the Performance of High Voltage Insulators in Polluted Atmospheres" (27th November issue, page 758) we referred to Mr. N. C. Blythe (B.I.C.C.). The speaker was, in fact, Mr. M. C. Blythe, who is sales director of Doulton Industrial Porcelains, Ltd.

INDUSTRY AND THE HOUSE

Thoughts on Science and Research

By AUSTEN ALBU, M.P., B.Sc., A.M.I.Mech.E., M.I.P.E.

OVERHEARD in the corridors of the House of Commons: Member in hat and coat having just arrived: "What are they on?" Policeman: "Still on Science." Member (apathetically): "Oh, Science!" Nevertheless, science received a good deal of attention from parliamentarians last week. It was the subject of debates in both Houses and the Parliamentary and Scientific Committee held a conversazione at the Royal Society at which a number of Members saw films, models and scientific equipment and enjoyed refreshment in the historic rooms.

The debate in the Commons took place when the Opposition decided to use half a supply day to discuss the Supplementary Estimates arising out of the creation of the office of the Minister for Science. A good deal of play was made with the fact that the Minister was in "another place" and Members on both sides demanded at least a Parliamentary Secretary, directly involved in the work of his department, to answer for him in the Commons. Mr. Anthony Greenwood, speaking for the Opposition, believed that it was wrong that we should have six Ministers answering for the Minister of Science in the House. He thought he had a more adequate staff than when he was Lord President of the Council, but was worried about the apparent lack of senior scientific members among them.

Minister's Responsibilities

Sir Edward Boyle, Financial Secretary to the Treasury, opening the debate, practically confined himself to listing the large number of bodies for which the Minister was responsible, viz. the Atomic Energy Authority, the four Research Councils, and the three advisory bodies: the Advisory Council on Scientific Policy, the Overseas Research Council and the Steering Group for Space Research. He also told the House that the Minister had asked the Advisory Council to advise him on the balance of our national effort and help the Government in the detection of gaps in our national scientific activities.

Several Members took up the point that the Government was faced with difficult problems in determining priorities in research and development and that in some fields we could not "go it alone." Sir Arthur Vere Harvey said that it was hopeless for this country to compete with the United States in all the fields of aircraft research and development and suggested closer working with the countries of the Common Market.

Another problem with which the Minister is faced is that of infusing a scientific spirit into some of our more backward industries and pleas were made for the use of development contracts and the establishment of special research development companies where other methods failed.

The Lords had the advantage of more time and of not having to play *Hamlet* without the Prince. Their debate also took place immediately after the publication of the annual report of the Advisory Council on Scientific Policy and the second report on Scientific and Engineering Manpower. It took place on a motion by Lord Taylor, himself a research scientist in medical matters. The wide field that he covered demonstrated the difficulty of parliamentary discussion of such a vast subject and the Minister himself seemed rather lost among his great responsibilities. Lord Taylor, while praising the Medical Research Council, thought that sometimes its membership of "very senior people" might lead to their not trying out new ideas outside the conventional run of thinking. It might also tend too much to back good men rather than to find men to tackle given problems. He made the new suggestion that the D.S.I.R. should be split into four separate Research Councils: Physical, Chemical, Engineering and Industrial. He finished, as did your contributor speaking in the House of Commons, with a plea for more support for the social sciences and revived the idea of a Social Science Research Council. In this he was supported by Lord Adrian, speaking with all the authority of an outstanding natural scientist; and by Lord Beveridge who hoped to see natural science in working contact with social science at the new Churchill College at Cambridge.

Space Research

The Minister, perhaps replying to criticisms in the "other place" which he was so loath to leave, said that he wanted to make himself as much accessible to its members as to their Lordships. He made brief reference to the Government's policy on space research, hoping that within two years British instruments might be in orbit round the earth. He believed that this modest, but well thought-out programme would enable us to "get our feet wet in the waters of space at the earliest possible moment." But Lord Jellicoe and Lord Shackleton, who wound up for the Opposition, thought that this programme was inadequate. The Minister, in defending the creation of his office, pointed out that although it consisted of a staff of only thirty-nine, it was responsible for the expenditure of £92 million in the Atomic Energy Authority and probably another £20 million elsewhere for civilian purposes.

A discordant note was struck by Lord Morrison of Lambeth, himself an ex-Lord President of the Council. He thought that the job could still have been done by the Lord President without the creation of a new office.

The result of these two debates is that the Minister has a lot of suggestions for his small staff to study and for himself to consider. As Lord Adrian reminded him, he is not only concerned with work which may bring an economic return in the near future, but also with that basic research without which our universities could not flourish. Suggestions for helping this by new methods of financing research in the universities, especially for technical assistance, were made in both Houses. There still remains the question of whether we are doing sufficient, outside the field of research for defence purposes, and whether we are producing enough qualified men and women to meet the demands of the future. To these matters Parliament will have to return again; perhaps after the Minister has had the opportunity to digest the advice he has been given.

A uranium plant in the Orange Free State

URANIUM PRODUCTION

By a CORRESPONDENT

Contracts for the supply of uranium ore will begin to expire in the next few years. This leads the author to discuss probable long-term demands for civil and military purposes. The value of world reserves of uranium ore suggests that adequate supplies are available to meet this demand. South Africa is better placed than other suppliers since her uranium is found in gold-bearing ore and is largely produced as a by-product of gold mining

THE Conference on the Peaceful Uses of Atomic Energy held at Geneva in the latter half of 1958 has provided a useful picture of the pattern of nuclear power development, and forms a valuable background against which to discuss the future of uranium in the atomic age.

For the world's budding uranium industries, of course, there can be no more fascinating questions than those that stem from this discussion. Posed in Parliamentary manner, they might be set out thus: " Does uranium have a future as a source of power? If so, will there be sufficient uranium to meet the demand; if so, who will be best placed to supply it? " Lacking the power of prophecy, the answers offered must be tentative. Imponderables abound; and, despite the pessimism in some quarters, in no other sphere has the achievement, technical and commercial, so markedly outstripped expectations.

The United Kingdom continues to blaze the trail in the West with a programme of nuclear power station construction of between 5,000 and 6,000 MW, in operation by the end of 1966. The United States, despite her immense reserves of coal and oil, and her resources of cheap hydro-electric power, is making great strides in the development of nuclear power. According to one estimate, after 1975 half, and in some areas all, the power stations built will be nuclear. Clearly the United States does not intend to lag behind the United Kingdom and Russia.

Generally, the countries which have been first to inaugurate substantial nuclear power programmes are those who are entirely without oil or coal, like Italy and Japan, or those who are unable to meet mounting power demands by conventional methods like France and the United Kingdom. These countries plan to have nuclear power stations in operation by 1965 which will have a capacity of 8,000 MW in Western Europe and 300 MW in Japan.

Thereafter, it may be expected that many other countries will be faced with power demands and fuel shortages that will necessitate the building of nuclear power stations. A dozen such countries already have active nuclear programmes. It has been estimated that by 1975 there may be more than 50,000 MW of nuclear power installed, excluding Soviet Russia and her satellites.

Across the Iron Curtain, Russia has launched a most ambitious initial programme, aiming at 2,000-2,500 MW next year. It is clear, therefore, that massive progress in the introduction of nuclear power will take place in the second half of the 20th century.

Mining Contracts

So far, the major demand for uranium has been military. Lord Plowden, the then chairman of the United Kingdom Atomic Energy Authority, a few years ago estimated that military demand would remain at something within 30,000 short tons of uranium oxide a year. It is known that Britain and America have either jointly or separately entered into long-term contracts with all producers in the Free World and that the bulk of this is required for the making of nuclear weapons, or for accumulating in the nuclear arsenals or stockpiles that have become an integral part of modern strategy and great power defence.

In South Africa, for example, the capital costs of building the country's 17 uranium plants and ancillary sulphuric acid plants handling material from 26 producing mines were met by loans from United States and British sources. Nearly £61 million was provided for uranium plants and auxiliaries and about another £9 million for sulphuric acid plants.

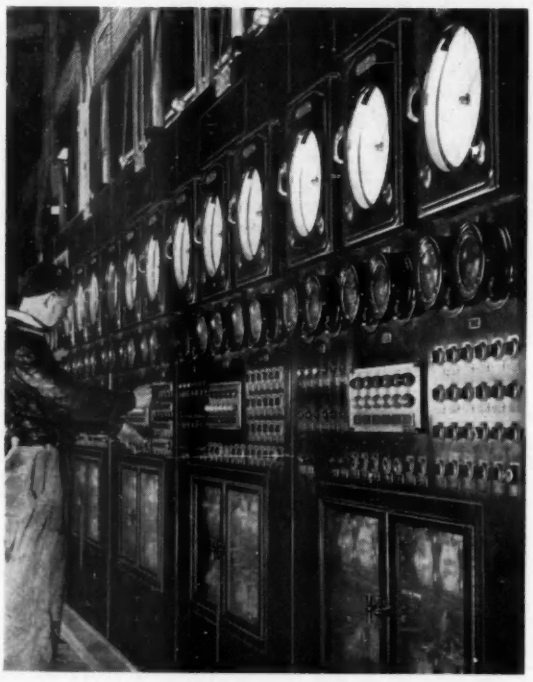
In terms of the contracts negotiated with the Combined Development Agency, a joint British-American undertaking, the South African Atomic Energy Board buys uranium oxide from producers and re-sells it to the Agency. The price paid provides for the redemption of the capital costs of the plants, as well as interest on the loans and profit.

The contracts the individual mines have with the Atomic Energy Board and the Combined Development Agency will expire between 1963 and 1967. By that time the capital loans will have been redeemed. The effect of the contracts in South Africa has been the creation of a new major export industry providing more than £50 million annually in foreign exchange. And this has been achieved in just six years.

Some easing of the demand for uranium was reflected last year in a move by the Combined Development Agency to impose a limit on purchases from South Africa. Subsequent negotiations resulted in the conclusion of an agreement with the Agency fixing purchases of uranium oxide from South Africa at the maximum of 6,200 short tons a year—a production level which the six-year-old industry was then approaching. This figure will be subject to reduction as each producer's contract expires. The agreement permits South Africa to seek outside markets for surplus output and the sale of a small quantity of uranium has already been negotiated. There is no doubt that South African production can be greatly expanded to meet any demand that may eventuate.

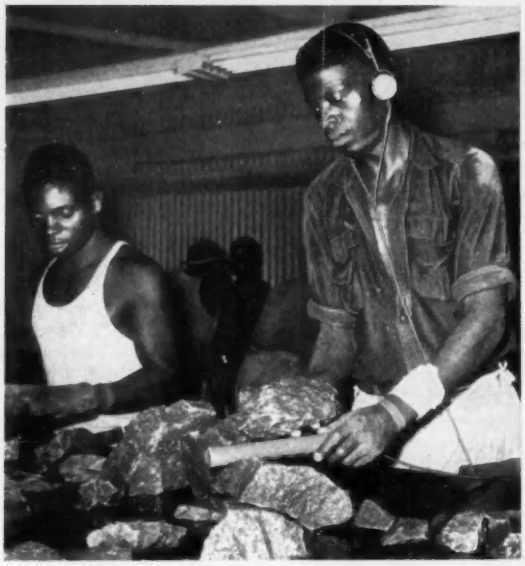
The introduction of this ceiling reflects the rapid expansion of uranium production by the three major producers. It is believed, too, that the market for uranium for civil purposes will be small for the next seven or eight years in relation to the productive capacities of the mines. This anticipation of a bleak period for uranium producers was reflected in the recent extension by three/four years of the contracts between the United States Atomic Energy Commission and Canadian producers which were due to expire in 1962 and 1963. However, study of the nuclear programmes suggest a steady increase in demand from the late 1960's onwards.

The main control panel connected with the ion exchange process of a uranium producing gold mine in the West Rand, South Africa



Reactor Development

There are, of course, many imponderables. Nuclear power stations consuming uranium cannot compete with conventional power stations when there is a cheap supply of coal or oil readily available where the power is required. Moreover, natural uranium is a relatively inefficient form of uranium fuel. Enriched uranium fuel has been evolved and is becoming more generally available, resulting in a reduction in the quantity of fuel required for a given



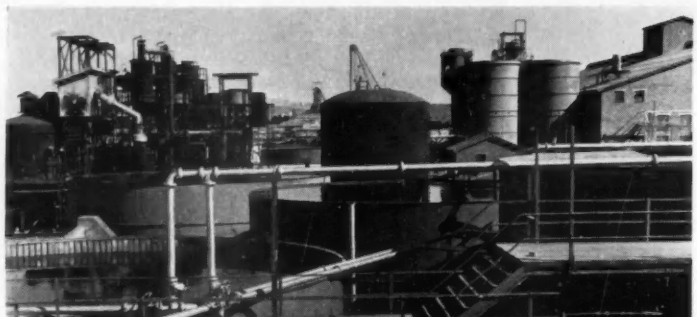
An African mineworker on a South African gold mine uses a portable Geiger counter to ensure that uranium-bearing ore does not "escape" to the waste dumps

output of electrical power. In addition, progress is continuing in the design of thermal "breeder" reactors employing thorium, but the problems of widespread use for energy purposes remain unsolved. Finally, there is the possibility of thermo-nuclear power.

The fusion process has, theoretically, important advantages over the fission of uranium or thorium. Fuel would be cheap and abundant, and far greater energy would be released. However, progress on its development is slow, with problems of the creation and control of vast temperatures still to be overcome. The best authorities doubt whether its commercial introduction will be achieved before the end of the century.

Uranium Demands

Indeed, despite these imponderables, many believe that the demand for uranium will expand rapidly in the 1970's. There are cogent reasons for this. A military demand will remain, coupled, as has been shown, with an expanding civil demand. Long-term estimates of world power requirements indicate a world shortage of coal and oil and a survey suggests that many countries are exhausting their hydro-electric resources. Nuclear power has arrived just in time. Moreover, world power requirements are rapidly expanding. Industrialisation is spreading and becoming intensified. Under-developed countries are



A uranium plant at a gold mine. With a few minor exceptions, uranium is produced in South Africa as a by-product of gold

undergoing a process of change which will create ever-greater demands for electric power.

Nuclear power is becoming slowly more competitive as conventional fuel sources become exhausted or more costly to process and transport, particularly in areas where the demands for fuel are great and available local resources are few. The world is experiencing a period of intensive experimentation which must result in reductions in capital costs that will enhance the low fuel costs of nuclear reactors. The curtain of secrecy over developments in the nuclear field has been largely lifted, stimulating competition and creating new markets for uranium.

The application of uranium to other purposes may well be extended. A major sphere is that of ship propulsion. *Nautilus* and other United States submarines have made spectacular voyages. The Russian ice-breaker *Lenin* will use nuclear power and the United Kingdom is constructing a nuclear submarine. The United States is building the *Savannah*, a nuclear powered merchant ship which may lead, though probably not in the near future, to the possibility of economic competition with conventionally powered vessels. In the future the long-distance oil tanker requiring big power units may be nuclear powered.

Experiments are being made with district heating and industrial process heating in Scandinavia, and there are, too, the medical and industrial uses of the by-products of fission. The use of nuclear power for aircraft and rocket propulsion will probably remain purely strategic for the foreseeable future, but it serves to indicate the wide fields of possible nuclear power development.

But the military stockpile and the nuclear power station remain the principal destination of the world's uranium output. Sufficient has been said to indicate that the demand for these purposes should steadily expand.

Estimated Reserves of Ore

Free world production last year has been roughly estimated at some 37,000 short tons of uranium oxide, of which more than 30,000 short tons was provided by the United States, Canada and South Africa. Known ore reserves of the three big producers have been estimated at:—United States 82·5 million short tons, Canada 377 million short tons, and South Africa 1,100 million short tons, giving a uranium oxide content of about one million tons. For a time, perhaps, a situation of surplus production may develop. When that period is over there should be adequate uranium reserves in the world to ensure the required supply.

A glance at the world map of known deposits of uranium, displayed in the South African exhibit at Geneva, shows how widely uranium is distributed. Although South African production far exceeds that of France and Australia, the next biggest producers, uranium has been found in numerous countries, and awaits exploitation when the economic times are ripe. Indeed, the fact that some of these deposits cannot be developed as economically as the large concentrations of ore located in Canada, the United States and South Africa has not prevented their exploitation. The insistence on bilateral agreements incorporating safeguards on end-use and the desire for national or strategic supplies has encouraged potential users to develop domestic deposits regardless of cost.

Conclusion

It is reasonable to predict that the market for civilian purposes will be relatively small though growing for, perhaps, a decade, and that thereafter it will expand at an ever-increasing tempo. By the end of the century, the world will probably be consuming two or three times as much energy as now and much of that increase should be supplied by nuclear power stations burning uranium fuel.

In the interval between the expiry of contracts and the unfolding of nuclear programmes, the uranium market may become highly competitive. In this period, South Africa will be particularly well placed, because her uranium is found in gold-bearing ore and is nearly always produced as a by-product of gold mining. Unlike her major competitors, South Africa does not have to establish and develop mines to obtain uranium ore and the resources of the world's greatest gold mining industry are available to make the production of uranium economic and the price competitive. Thereafter, on the basis of estimated reserves, the South African uranium industry should have at least 50 years of continuous production.

It may be fairly assumed, therefore, that the world possesses adequate supplies of uranium to meet the 20th century's atomic revolution, and that as these supplies start to dwindle new atomic fuels will be made available.

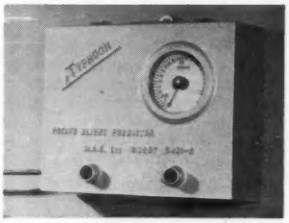
U.S.S.R. Production Developments

THE 1959 Sir Alfred Herbert paper was presented to the Institution of Production Engineers last week by Dr. P. F. Galloway. The paper, entitled "Recent Production Developments in the Soviet Union," gave some impressions obtained during a five-week tour of the Soviet Union, Poland and Czechoslovakia by a delegation from the Production Engineering Research Association of Great Britain. The observations mainly concerned production engineering research and development, general industrial development such as automation, and the engineering and scientific information services. Comments were also made on working conditions, wages, incentives and general standards of living.

Smithfield Show

EQUIPMENT ranging from heavy tractors and combine harvesters to such items as an impulse starter claimed to eliminate the need for starting engines with lengths of cord were to be seen at the Smithfield and Agricultural Machinery Show which was held at Earls Court, London, last week. Milk production in all its aspects, movement of feeding stuffs, crop drying, and even muck handling, are all tasks that can now be done more efficiently and speedily with the aid of electricity and many of the exhibits on the various trade stands emphasised the advantages of electrical methods.

On the British Electrical Development Association's stand actual examples were shown of electrical plant and accessories for drying grain and grass, both in batch and in bulk. These were supported by enlarged photographs of typical installations on farms in various parts of the country, together with tabulated details of the results obtained. Among the items displayed were a Matthews & Yates twin motor axial flow foot-mounted fan for barn hay drying by the storage method; a Modern Appliance & Equipment "Typhoon" universal crop dryer with a 15 h.p. motor and a 30 kW heater, shown as a tunnel dryer applied to baled grass and grain in sacks; a Templewood Colman barn hay drying unit with two 4 h.p. fans and an 18 kW heater; a J. W. Woolley & Co., Ltd., all-electric tunnel dryer, with a 10 h.p. motor; a G.E.C. 3 kW fan heater unit; and electric hygrometers or moisture indicators (Opancol & Marconi) for measuring the moisture content of grain and grass.



"Typhoon" potato blight predictor (Modern Appliance & Equipment)

Of particular interest on the E.D.A. stand was a new instrument, the "Typhoon" potato blight predictor. Whilst it is generally known amongst potato growers that blight can be recognised by the appearance of the leaves of the plant, the difficulty has been to tell when to take remedial measures to combat it. With the aid of this new instrument an audible and visual warning of any rise in humidity is given. If the condition persists for longer than 48 hours a warning bell comes into operation in conjunction with a red indicator lamp. The price of the instrument is £55 and it is estimated that the elimination of one unnecessary spraying of a reasonable-sized crop would cover its cost. The "Typhoon" is manufactured by the Modern Appliance & Equipment Co., Ltd., and is suitable for use on 200/250 V single-phase supplies.

The motor and control gear division of Associated Electrical Industries exhibited a comprehensive range of electrical equipment specially applicable to farming interests and agricultural machinery. On view was the company's "Stayrite" single-phase power drive, now available from 2 to 10 h.p., the range having been extended by the addition of 7½ and 10 h.p. ratings. Motors up to 5 h.p. can be either drip-proof or totally-enclosed fan-cooled types and supplied with either a hand-operated or a pushbutton starter. The A.E.I. also exhibited many other motors, including f.h.p. types and models of f.h.p. geared motor units. The "Pyroflector" range of infra-red heaters for pig and poultry rearing was demonstrated, these now being available with loadings of either 300 or 600 W, the latter with or without a pilot light. Also of interest on the A.E.I. stand was a daylight-operated photo-electric relay, with its associated time switch and contactor, for controlling artificial lighting in poultry houses.

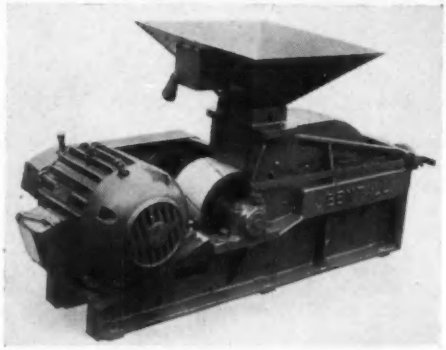
"Microsol" model 303T mist generator (Gordon Felber & Co.)

Infra-red heating equipment in the form of animal warmers, of G.E.C. manufacture, was shown by the Simplex Dairy Equipment Co., Ltd., who also exhibited a range of potato chitting lighting equipment.

Scottish Mechanical Light Industries, Ltd., demonstrated several types of grain dryers and blowers, including a 5-ton batch dryer. "Scotmec Electromatic" hammer mills with built-in 5 h.p. three-phase or 3 h.p. single-phase motors, and a multi-bagger for fully automatic grinding were displayed. Up to six bags can be filled simultaneously and a "no-load" relay with mercury switch shuts off the motor when grinding is completed.

On the C.A.V. stand there was a representative selection of electrical equipment for tractors and stationary and portable engines, dynamos, starters, lamps, batteries, etc., while the Lucas stand showed starting, ignition and lighting systems as fitted and recommended for all types of tractors and agricultural machinery. The Lucas "Milam" standard and heavy duty batteries for replacement service now include the new "S" range.

Several manufacturers of refrigeration equipment took the opportunity of displaying equipment at the show. Prestcold had on view a new de-luxe model of their



Bentall's corn crusher fitted with A.E.I. "Stayrite" single-phase motor

"Farmoor" frozen food sales and display case. Other items in the Prestcold range were represented, including a 150 cu ft "Cleanline" coldroom operated by a ½ h.p. condensing unit. Kelvinator exhibited a new 19·6 cu ft farm freezer, completely equipped with an adjustable partition, racks, safety light and an insulated flexible lid. Another company to exhibit a new refrigerated display case was Lec Refrigeration, Ltd., who showed their new "Junior Salesman." With a capacity of 7·1 cu ft, it has a slide-away night cover and provision for an attractive dummy display.

Dairy produce and frozen food conservators were included among the exhibits of Marco Refrigerators, Ltd., while J. & E. Hall, Ltd., had a "Hallmark" flake ice maker capable of producing one ton of ice per day.

Pest and bacteria control in buildings where livestock are housed and in broiler houses is of importance and spraying equipment for this purpose was shown by Gordon Felber & Co., Ltd. This company exhibited their "Microsol" mist generators and had on view for the first time their model 303T designed for larger buildings. The tank of the apparatus can accommodate up to 5 gal of insecticide at one time and the machine has an output of 25 gal/hr with a throw of 165ft. It is driven by a ½ h.p., 1,600 r.p.m. motor.

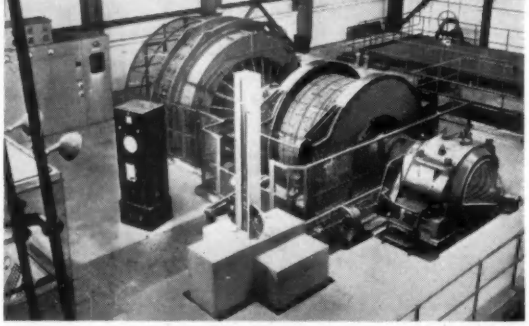
Apart from electric fencing equipment, insulators, posts, etc., Wolseley Engineering, Ltd., exhibited for the first time a range of magnetic plates. These plates can be installed quickly and easily into existing grain or feed chutes and, once fitted, attract any iron and steel particles which may have accidentally been mixed with the grain or meal, thus protecting both the animals and the machines. Normal vibration is said not to affect the magnetic strength and special assemblies can be designed for any application.

Another company to exhibit electric fencing equipment was Curtis, Padwick & Co., who showed the "Koltec" range. Included in this is a combined fox scarer and electric fencing unit. This last-named item incorporates a neon bulb which flashes approximately 50 times a minute and is designed for protecting game preserves and turkey and chicken farms.

WARSOP COLLIERY FRICTION WINDERS

AN entirely overhung armature is being used in new tower-mounted friction winders supplied by the A.E.I. Heavy Plant Division to Warsop Colliery in the East Midlands Division of the National Coal Board. Only two main bearings have therefore been required and this accommodates the deflection and distortion of the winder unavoidable in a steel-framed tower. The cage-winder motor for No. 1 shaft is rated at 1,334/1,940 h.p. at 78·4 r.p.m., and in No. 2 shaft, where skip-winding is employed, the winder motor is rated at 1,638/2,120 h.p. at 77·3 r.p.m. Each has Ward-Leonard control, with a laminated exciter closed-loop system which provides accurate speed control and sets a limit to the torque for acceleration.

The two motor-generator sets are situated at ground level, but the distance which separates them from the winders is unimportant, since the use of high armature voltages makes the employment of light cable possible, and the small voltage drop is compensated for automatically by the closed-loop control system. A synchronous induction motor rated at 830/1,124 h.p. at 750 r.p.m. drives the 840/1,537 kW generator supplying the No. 1 shaft winder; and a similar motor, rated at 1,165/1,263 h.p., drives the 1,071/1,678 kW, 750 r.p.m. generator for the skip-winder motor. A changeover switchboard allows either winder motor to be supplied by either generator.



The skip winder in No. 2 shaft at Warsop Colliery is driven by a 1,638/2,120 h.p. A.E.I. motor

Men and materials only are wound in No. 1 shaft, and coal exclusively in No. 2, which has an automatic winding system depending on the flow of coal from the face. The arrival of a skip at the underground filling station operates a magnetic proximity switch which begins the sequence of operations by loading coal into the skip and then switching the flow of coal from the tipplers to the appropriate measuring pockets. Automatic winding can be carried out continuously, but if the operation is interrupted by an emergency the cycle of operations must be completed manually before automatic winding can be resumed.

A two-rope winder is used with two-deck cages and a pay-load of four tons in the 1,338ft deep No. 1 shaft. The rope drum has a diameter of 11ft and the cages are wound at a speed of 45ft/sec. In No. 2 shaft a four-rope winder is installed with two skips, each of eight tons capacity. The rope drum is 8ft 6in in diameter and therefore, although the direct-coupled motors on each equipment operate at almost the same speed, the rope speed in No. 2 shaft is only 35 ft/sec, giving an output of 400 tons an hour from the 1,421ft depth.

The mechanical parts of the two winders, as well as the structural steelwork of the towers, were supplied by Guttehoffnungshutte—the structural work in consultation with Husband & Co., of Sheffield. Siemens & Halske were also sub-contractors.

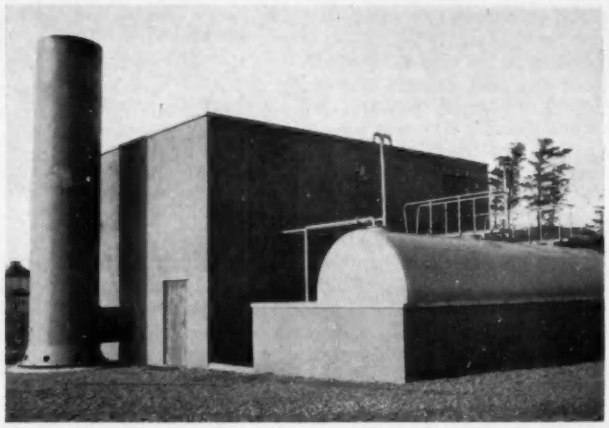
Arrangements for M.C.T. Award

DETAILED arrangements for the new award of Member of the College of Technologists (M.C.T.), which provides a qualification in the field of technology equivalent to the Ph.D. degree, were announced recently by the National Council for Technological Awards. The establishment of the College of Technologists to administer the award was announced in May last year.

A memorandum has been issued for the guidance of applicants for the award and colleges and industrial organisations concerned. One of the principal features is that the programme of work must be carried out jointly both in industry and at a college and may be concerned with any technological aspect of industrial activity. The programme must be one which is likely to result in a useful contribution to technological knowledge. The period of study the College of Technologists has in mind is three years. Copies of the memorandum can be obtained on application to the College of Technologists, 9, Cavendish Square, London, W.1.

Remotely Controlled Power Station

3 MW AUTOMATIC GAS TURBINE PLANT COMMISSIONED



The power station at Princetown showing the fuel tank and the exhaust system

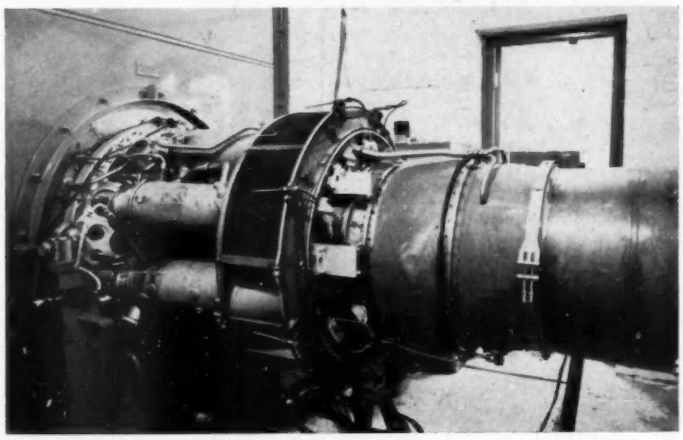
THE first automatic gas turbine power station at Princetown, Devon, was started up last Friday by "Datafonic" supervisory control from Bristol. Mr. C. R. King, chairman, Electricity Council, who performed the ceremony, said it might seem paradoxical that, while the Central Electricity Generating Board was building large power stations and shutting down the smaller stations, a 3 MW plant had been installed on Dartmoor. The new station was, however, designed for peak-load, standby and emergency operation and was, in fact, more economic than providing a duplicate power line to the area.

The power station contains a 3 MW gas turbo-alternator which is a development of the Bristol Siddeley "Proteus" aero engine (as used in the *Britannia*) and an 11 kV Electric Construction Co. alternator. A full description of a typical installation appeared in the *Electrical Review* of 1st May, 1959. The overall length of the complete turbo-alternator at Princetown is less than 27ft. The low weight and freedom from vibration mean that only minimum foundations are required, so that the power station building can be simple and light as well as being small. The site is not dependent on a water supply as no cooling water is required.

The engine is a simple free turbine two-shaft unit rated at 4,250 h.p. operating on diesel fuel. No warming-up period is required and it is estimated that routine visits need be paid to the station only four times a year while turbine overhauls will be required about once every ten years. Since the power turbine is mechanically separate from the compressor and its turbine, the compressor system can run at maximum speed under all conditions, while the speed of the power turbine can be varied as required. The power required for starting is relatively low since only the compressor system is rotated by the starter motor. Automatic synchronising is also facilitated as the alternator is connected to the low inertia power turbine only. This connection is made through a compound epicyclic reduction gear at one end of the engine, and the alternator is driven at 1,000 r.p.m.

The alternator is unusual in that the rotor is supported in thin wall bearings, oil pressure fed, with the oil reservoir in the bedplate. The bearings are arranged for self-lubrication, in the case of oil supply failure, for one hour without overheating. The machine is designed with controlled inertia and low static friction to help starting, and the 5-ton rotor was dynamically balanced to an accuracy of 4 to 5 in-oz. Preformed moulded mica was used to insulate the stator windings to withstand system surges. The alternator is switched direct on to the 11 kV system and field forcing is used to give full load stability within three seconds.

The starting sequence is entirely automatic and the unit is controlled by the "Datafonic Mark II" system. The Mark I system was described in our issue of 6th November last. The Mark II development includes control and telemetering facilities in addition to supervisory information. The system operates over public telephone lines and avoids the use of private or rented lines. The equipment at Bristol enables full control of the power station at Princetown to be carried out from the South Western Electricity Board's new control centre in Bristol. In the event of a change of state in the running conditions of the set or operation of any of the protection systems, the equipment installed in Princetown automatically engages its own exchange line and verbally requests the public exchange operator to connect it with the Bristol control room. When the call is put through, the duty engineer in Bristol hears the equipment announce its identity, after which all control and telemetering facilities are available.



The power unit which has been developed from the Bristol Siddeley "Proteus" aero engine

In an introductory talk, Mr. A. N. Irens, chairman of the South Western Electricity Board, said that a possible solution to the twin problems of reliability of supply and low cost peak generation was the provision of a plant having low capital cost, automatic starting and unattended running under automatic control, the acceptance of full load in the shortest possible time from initiation of starting, the ability to stop and start after standing idle for long periods, and absolute reliability. To meet these requirements, the fully developed aircraft type gas turbine would appear to be the most suitable.

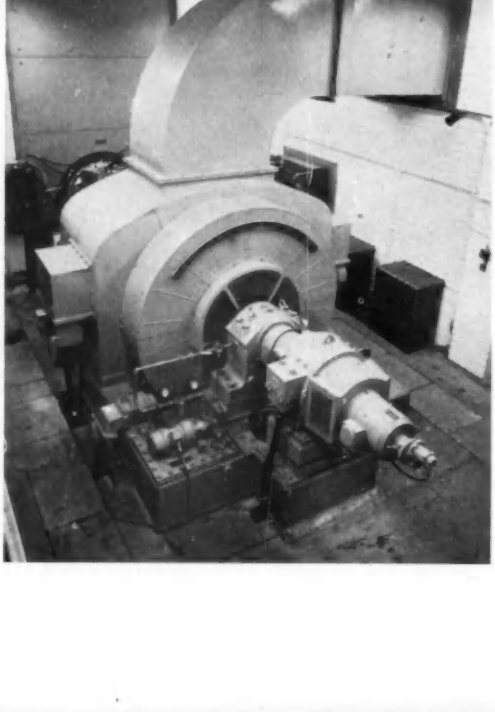
In the case of the set at Princetown, the South Western Board has the advantage of the lengthy development work which has already been carried out on the turbine for aircraft application. It is estimated that the cost of the complete installation is about £80,000, equivalent to about £25 to £27/kW.

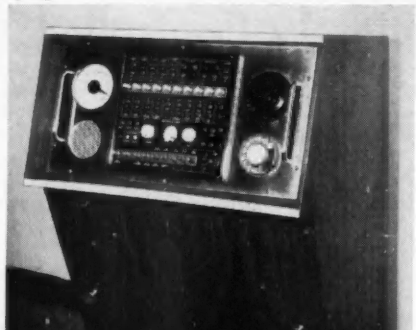
Operating Conditions

During the opening ceremony the machine picked up full load in 2 min 10 sec. The running cost is rather high because of the relatively low thermal efficiency, but this is of small consequence when running under emergency or peak lopping conditions. Undesirable noise has been eliminated by means of intake and exhaust silencing equipment. Mr. Irens said that it was only a year ago that the first talks with Bristol Siddeley Engines took place, and it was only last April that the consent of the Minister of Power was received to go ahead.

In parallel with this project, one of the most up-to-date control centres for the distribution of electricity was opened in Bristol by the Lord Mayor, Councillor W. G. Cozens. The main feature of the control room is a 40ft diagram on which is represented the 2,000 miles of high-voltage mains and 2,800 substations in the local distribution system. The system running conditions are shown on the diagram so that in the event of a fault a control engineer can direct by telephone or v.h.f. radio

The 3 MW 11 kV alternator. The reduction gear can be seen protruding between the gas turbine and the alternator





The "Datafonic" control panel which has been installed in the Bristol control centre

the activities of the field operating engineers. The control room also contains the "Datafonic" equipment for the control of Princetown.

A second set has been ordered by the South Western Electricity Board in the Lynton area of Devon. Among the projects now being developed by Bristol Siddeley is a 15 MW turbo-alternator utilising as the prime mover a version of the Olympus engine as used in the Avro *Vulcan* bomber.

Collaboration in Fusion Research

THE United Kingdom and Euratom last week agreed that it was desirable to organise and develop close collaboration in the study of controlled thermonuclear reactions for peaceful purposes including exchange of personnel and comparison of programmes with the object of avoiding unnecessary duplication of effort.

The first meeting of the continuing committee for co-operation discussed the progress made since the signing of the United Kingdom-Euratom agreement on 4th February this year. The committee considered suggestions for co-operation between the Commission and the United Kingdom Atomic Energy Authority on fast breeder reactor techniques. The advanced gas-cooled reactor system was also discussed and it was agreed that a preliminary technical meeting should be held in January next.

The committee agreed on these proposals after hearing a report of the work already accomplished at the technical level by the joint working group (which consists of officials of the two organisations).

The community was represented at the meeting by M. Etienne Hirsch, President of the Euratom Commission, and M. Emmanuel Sassen, a member of the Commission. Lord Hailsham, Lord Privy Seal and Minister for Science, and Lord Plowden, chairman of the Atomic Energy Authority, represented the United Kingdom.

During their visit the Euratom representatives visited the Central Electricity Generating Board's nuclear power station at Bradwell and the Atomic Energy Research Establishment, Harwell.

SEMICONDUCTOR RECTIFIERS

Authors' summary of a paper entitled "The Characteristics and Protection of Semiconductor Rectifiers" by D. B. Corbyn, B.Sc.(Eng.), M.I.E.E., and N. L. Potter, B.Sc.(Eng.), D.L.C., Graduate I.E.E.,* read before the Utilisation Section of the Institution of Electrical Engineers on 10th December

RECTIFIER technique has changed so greatly during the last few years that a complete re-examination of protection methods has become necessary. Germanium and silicon rectifiers have supplanted mechanical, selenium and mercury-arc rectifiers in a very wide field of application. The more recent advent of the controlled rectifier will still further accelerate development.

Semiconductors can be damaged by overcurrent or overvoltage. Co-ordination of all protective devices, the control of voltage and current surges and the establishment of ratings which give an adequate life are necessary for reliable operation.

Voltage and Current Characteristics

All cell failures eventually mean inability to withstand reverse voltage even though the primary cause may be overtemperature, overcurrent or overvoltage. The safe reverse voltage is determined for each cell in working conditions (either real or simulated), i.e. by dynamic testing both in normal operation and when voltage surges are applied. This voltage is defined by a leakage current limit, a reverse power dissipation, or voltage breakdown. In some rectifiers, the reverse voltage which can be withstood for very short pulses is appreciably above the normal recurrent reverse voltage. In practice, voltage surges always occur and the inverse voltage which the rectifier can withstand must be chosen to have an adequate safety margin above the reverse voltage in the circuit.

Voltage peaks are produced by "hole storage" commutation phenomena in the rectifier and are controlled by resistance-capacitance networks. Transformer switching may produce very severe voltage surges especially when switching off an unloaded transformer. Surge arrestors or resistance-capacitance networks on primary or secondary reduce switching surge voltages. Small capacitors from secondary lines to earth prevent the transfer of dangerous voltage through the inter-winding capacitance of the transformer. Surge voltages attributable to lightning can be reduced by the use of suitable surge divertors.

Rectifier fuses are designed with limited arc voltages, and surges due to load current chopping caused, for example, by d.c. circuit-breaker operation are controlled by resistance-capacitance networks on the rectifier output or transformer secondary. The various methods of surge suppression are illustrated in Fig. 1.

The safe working current is limited by the junction temperature, which must be chosen so that ageing effects are negligible in service and also give an adequate margin for overload and fault conditions. Transient junction temperature can be reliably estimated by an electrical analogue of the heat transfer system.

The current-time survival curve is obtained for the rectifier and the protective system is then designed to ensure that the safe current limit is never exceeded.

Rectifier Fuses

The energy required to destroy a fuse can be found, as also can the energy to destroy a rectifier cell. Then by matching these two components protection can be obtained.

The fuse required must satisfy exacting requirements. It must have high rupturing capacity and must limit both total energy dissipated and peak "let-through" current reached in a rectifier during a fault. It must have a limited arc voltage and must carry full load current indefinitely without deterioration, must be small for mounting near the rectifier cell and must have stable repeatable characteristics which can be co-ordinated with the time/current characteristics of other devices.

Protection Co-ordination

The overall protection is provided by the combined use of fuses, a.c. or d.c. circuit-breakers or contactors, and possibly short circuiters. Internal faults are usually allowed to blow a fuse, disconnect the faulty cell and sound an alarm. In small equipments, the circuit-breaker is usually opened to shut down the equipment and prevent

* English Electric Co., Ltd.

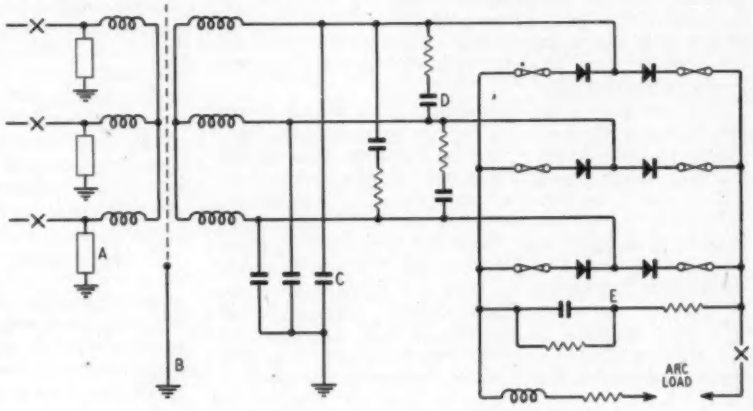


Fig. 1.—Various methods of surge suppression for semiconductor rectifiers

A. Surge divertors for lightning protection
B. Earth screen } Alternative protection against surges due to capacitance coupling
C. Low inductance capacitors } between transformer windings
D. Capacitors for hole storage protection and transformer switching surge protection
E. R-C circuit to absorb inductive energy

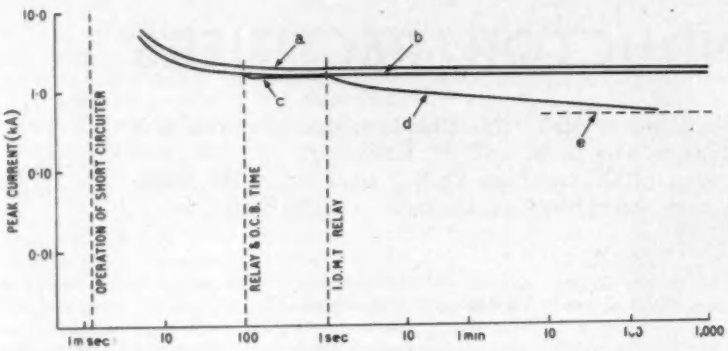


Fig. 2.—Co-ordination of complete overcurrent protection system for a typical semiconductor rectifier equipment

a. Rectifier cell survival curve
b. Fuse curve
c. Instantaneous relay
d. I.D.M.T.L. relay
e. Normal full load peak current

overloading of healthy cells. In special cases, operation continues at reduced load, and alarms are used to call attention to the need for load reduction. In large equipments, a warning of a cell failure is adequate since overloading is negligible and no immediate shut-down is necessary.

External faults must not blow fuses except as a last resort when all other means of protecting the rectifier equipment have failed. This can be achieved by proper co-ordination of the circuit-breaker settings and fuse characteristics and still further by the use of the short circuiter (which usually operates in well under two milliseconds) where appropriate. Fig. 2 shows the characteristics of a co-ordinated protection system.

Finally voltage surges are controlled by a combination of resistance-capacitance networks and surge divertors and the rectifier cell voltage chosen in conjunction with the precautions taken.

In the practical application of semiconductor rectifiers a number of related problems arise, varying somewhat with the application. To give warning of fuse operation a convenient method is to connect a small " striker pin " fuse across each main fuse. When the main fuse clears, the striker pin is ejected, sounds an alarm and when necessary trips the equipment.

For industrial power supplies, it is usually adequate to achieve all protection with an a.c. breaker and the rectifier fuses. Special precautions may be necessary for operation in parallel with machines, mercury-arc rectifiers or mechanical rectifiers. Furnace loads are often liable to short circuit and require either current limiting reactors or transductors, together with careful measures to prevent surge voltages.

Electrolytic loads are very steady, have neither severe overloads nor short circuits and are generally free from voltage surges. A major risk is a lightning strike on the overload supply lines and very careful voltage surge protection, usually by means of surge divertors, is essential.

Rectifier traction using high voltage a.c. on the catenary is growing rapidly. The major risk is a lightning strike necessitating careful surge protection. Motor flashovers occasionally happen and the fuses and circuit-breakers are co-ordinated to prevent fuse-blowing. Designs should preferably minimise the number of fuses and it should always be possible to drive the train home even if a rectifier section has failed or a motor flashover occurred.

DISCUSSION

The discussion was opened by Mr. J. A. Broughall (British Railways), who said that the railways wanted instruments which were reliable and simple. He hoped that the tremendous progress made in the last few years would be continued so that it would be possible to look on the semiconductor rectifier exactly as one looked on a switch. To this end the users must know the conditions in which the rectifier had to operate and the makers must grade and test in their works the individual components, so that the rectifiers could be installed and then forgotten.

Dr. W. G. Thompson (G.E.C.) said that while it had been hoped that the semiconductor rectifier would show the inherent qualities of self-protection associated with many other forms of electrical equipment, it would be some time before that ideal was achieved. The fact must be accepted that in many applications the semiconductor rectifier could function reliably only with a bodyguard trailing along behind it, but much of this was static equipment, such as condensers and resistances, or expendable fuses. It must be remembered that the semiconductor rectifier, being sensitive to voltage surges, had to be designed for maximum current and over-voltage conditions, so that in that sense, unlike some of the older types, it got the worst of both worlds; but its economic potentialities were very great and it had already demonstrated its value in practice.

Dr. J. C. Read (B.T.H.) believed that an article should be made strong enough itself to deal with the conditions which it had to survive, where that could be done without extra expense, rather than adding extra " gadgets " which might well be the source of other operating troubles. With very large equipments it was the practice of some engineers abroad to omit the d.c. circuit-breaker. When that was done it was clear that if there was an accidental short circuit across the output terminals of the rectifier the whole rectifier cubicle and perhaps much else would be destroyed. The user had to decide whether the saving was worth while. With two large semiconductor installations being manufactured in this country it had been found that the saving would be 6 per cent on the overall cost, and neither he nor the operating engineers concerned had thought the saving big enough to justify the risk.

Mr. B. C. Hicks (E.M.P. Electric) called attention to the development of h.v. h.r.c. cartridge fuses for semiconductor rectifier protection. These fuses would limit the maximum transient arc voltage to 1·5 times the peak inverse voltage rating and were an important step forward in protective devices, because in recent technical papers it had been stated that a ratio of 1·7 was the best that could be achieved with h.v. fuses.

Mr. D. H. Coleman (S.T.C.) pointed out that there was no mention in the paper of the protection needed to deal with an open circuit fault on a rectifier. With some forms of silicon rectifier an open circuit could occur and not merely the passage of overload current for a time before clearance. If due regard was paid to open circuit faults

there would not necessarily be justification for some of the authors' proposals.

Mr. Saysell (Mullard) said that if with the aid of the paper an attempt were made to design rectifiers to supply, say, 12 kV and upwards and 2-3 A, on the score of cost the advantages claimed in the paper would not be obtained. As regarded electrical efficiency the losses in large series strings were much higher than with the conventional rectifier valve.

Mr. J. M. Waddell, speaking as a cell manufacturer, said that in dealing with the smaller cells the tendency was for the user and manufacturer to be separated and the equipment designer might want to buy his cells from a number of manufacturers. This made it very important that they should all speak the same language. He illustrated the difficulty which arose when this was not done by reference to terms used in the paper.

Mr. R. A. A. Newman pointed out that the voltage surges which were most inconvenient to the small semiconductor device manufacturer were those occurring on the domestic mains supply, which might adversely affect the performance of silicon diodes in a television receiver.

Mr. K. L. Streeter felt that Mr. Broughall's fears about the complications of circuit protection in traction applications would before long be removed and that because of improvements in the devices most of the complexities of overload protection would disappear. The starting characteristics of traction motors and the duties imposed on them were not easy to assess, but in time they would become known and the use of protective devices could be limited.

Mr. Corbyn, in the course of a comprehensive reply, said that over-voltage protection was much cheaper than putting big safety factors on the voltage of the cells. Short-circuiters were good devices but not infallible and he was frightened by designs on the Continent in which a short-circuiter was virtually all that was used. The authors considered that in some cases, such as an ordinary system of factory distribution, the risk of a full short circuit was remote and it was justifiable to put in reasonably low reactance and face the risk, but it must be realised that there was a risk to be faced. In other cases the risk could not be taken because the chances of short circuits were very real.

200 MW SETS FOR AUSTRALIA

THE State Electricity Commission of Victoria has awarded a £3·6 million (sterling) contract to Australian Electrical Industries (Pty.), Ltd., acting on behalf of Associated Electrical Industries Export, Ltd., for the supply of two 200 MW steam turbo-generator sets and associated equipment. This is for the new Hazelwood power station to be built in the Latrobe Valley area of Gippsland about 90 miles east of Melbourne. The station will have an ultimate capacity of 1,200 MW. The A.E.I. contract also includes condensers and feed water heating plant, boiler feed pumps and make-up water plant, cranes and miscellaneous turbine house equipment. The turbo-generators will be made at the A.E.I. Trafford Park works and the principal items of heat exchange equipment, including the condensers, will be manufactured in Australia to A.E.I. designs. The contract for boiler plant and ancillary equipment, amounting to £7·6 million (sterling), has been placed with Babcock & Wilcox, Ltd.

The turbines will be three-cylinder tandem-compound impulse machines running at 3,000 r.p.m. with steam conditions of 1,500 p.s.i. and 1,050°F at the turbine stop valve. Double shell construction will be used for the high-pressure cylinder casing, and an intermediate-pressure section will be followed by three low-pressure flows, each incorporating a Baumann multi-stage exhaust. The h.p. rotor, the combined i.p./single-flow l.p. rotor, and the double-flow l.p. rotor will be machined from monobloc forgings with integral discs. They will be solid-coupled and carried by spherically-seated white-metalled journal bearings. A Michell thrust bearing will be housed within the pedestal between the h.p. and i.p. rotors.

Steam will exhaust to a twin-shell A.E.I. condenser which operates at a vacuum of 28in Hg with a cooling water supply of 72,000 gal/min at 69°F. Bled steam from the turbine will supply two low-pressure heaters, giving a final feed water temperature of 420°F from the five-stage system.

Two-speed motor-operated barring gear will be carried by the l.p. end pedestal, which will house a spherically-seated turbine journal bearing and the semi-flexible coupling between the turbine and generator shafts.

The generator voltage will be 15 kV, 50 c/s, three-phase. Cooling of the stator windings will be by water circulating in direct contact with the copper, while the rotor will be cooled by the forced circulation of hydrogen. The generator exciters will be gear driven from the 3,000 r.p.m. generator shaft.

I.G.Y. Radio Aspects

SOME of the radio aspects of the International Geophysical Year held between July, 1957, and December, 1958, were discussed in a paper prepared by Dr. R. L. Smith-Rose and presented recently to the I.E.E. Electronics and Communications Section.

During the year scientists of 66 nations worked at over 4,000 observatories throughout the world on a programme concerned with the physical properties of the earth and its atmosphere and with the related solar and terrestrial phenomena. Provision was made for the declaration of special periods when the sun's state indicated the likelihood of a geophysical disturbance which might have affected the ionosphere and the earth's magnetic field. A number of centres were set up to collect data relating to all aspects of the programme, the two main ones being in the U.S.A. and the U.S.S.R. while, in the radio field, additional centres were established in Japan and in England, at the D.S.I.R. radio research station at Slough.

From the observations made it was found that the maximum frequencies useful for radio communication circuits did not differ appreciably from those calculated on the usual assumption that the distribution in the F2 layer was parabolic, but the angle of arrival of the radio waves for a given distance between sending and receiving stations tended to be greater than that for a parabolic layer. Owing to the high solar activity prevailing during the year, the ionisation density and critical frequencies of the ionospheric layers reached unprecedented levels, adding greatly to the information available on the relationship between solar activity and critical frequencies essential for accurately forecasting the best radio communication frequencies.

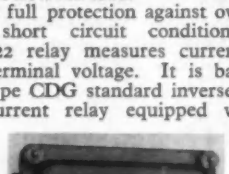
Work in the Antarctic showed the magnetic dip to be abnormally small and, while the general behaviour of the ionosphere was regular, some anomalies were observed.

NEW ELECTRICAL EQUIPMENT

Voltage Controlled Overcurrent Relay

An overcurrent relay to protect alternators against both overload and short circuits has been added to the range produced by the Meter, Relay and Instrument Division of the ENGLISH ELECTRIC CO., LTD., Marconi House, Strand, London, W.C.2. When used for main or back-up protection of alternators, overcurrent relays often require fault settings on loads close to full load in addition to giving normal overload protection, since the sustained short circuit current on external faults may be limited to a value below full load.

For full protection against overload and short circuit conditions the CDV22 relay measures current and the terminal voltage. It is basically the type CDG standard inverse time-overcurrent relay equipped with a



English Electric overcurrent relay

voltage sensitive element which permits it to discriminate between overload and short circuit conditions. To take advantage of the thermal capacity of most alternators the operating time under overload conditions is longer than the corresponding time provided on a standard inverse time-overcurrent relay. Under short circuit conditions a brief operating time is provided. This form of protection can be applied to solidly or resistance earthed alternators.

Portable Arc Welders

Two portable arc-welding machines, the "Midget" and "Twin Midget," have recently been produced by DOHM, LTD., 167, Victoria Street, London, S.W.1. The "Midget" machines have a maximum output of 160 A on the 50 V open circuit range or 120 A on the 75 V open circuit range, and operate from a 200/250 V single-phase input. A model is also available for operation on single-, two- or three-phase supplies. Both models have 15 variations of output current in each range and use 8 to 16 s.w.g. electrodes.

The "Twin Midget" operates with a 200/500 V, single-, two- or three-

Dohm "Midget" arc welder

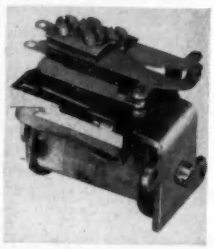
phase input and has 52 variations of output current in each range. It has a maximum output of 320 A. The cases are constructed from ⅛in steel plate with stove enamel finish in silver grey hammer. The "Midget" case is fitted with chromium plated folding handles, and the "Twin Midget" has castor wheels.

Infra-Red Detector

An equipment using an infra-red ray to give warning of unauthorised entry into premises has been produced by the BRITISH CENTRAL ELECTRICAL CO., LTD., Briticent House, 6 & 8, Rosebery Avenue, London, E.C.1. It comprises a projector, incorporating a rotating shutter producing 700 light pulses per second and having a push-button operated screen for the 45 mm diameter lens to select visible or infra-red light, a receiver with a photo-electric cell sensitive to infra-red light and a detector-contactor having a current breaking capacity of 5 A at 240 V a.c. The projector and receiver can be situated apart at a distance up to 550 yd, and the equipment operates from a 240 V single-phase supply. The use of a modulated beam prevents interference by extraneous lighting.

Impulse Relay

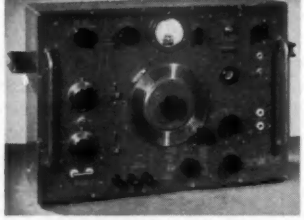
An impulse relay developed from the 596 series relay is the latest addition to the range produced by MAGNETIC DEVICES, LTD., Newmarket, Suffolk. A spring set on one side of the relay is alternately operated and released by d.c. voltage impulses whilst the contacts on the other side will follow the armature. The relay, which has approximate dimensions of 1 1/16in by 1¾in by 1¾in, can be supplied wirable or plug-in, enclosed or hermetically sealed. In the open pattern up to two changeover contacts can be supplied on each contact stack and in the enclosed or sealed versions a maximum of three changeover contacts are available, only one being on the impulse side. Coils for voltages up to 150 V d.c. can be provided. A relay suitable for use on a.c. can be supplied, the necessary blocking rectifier and smoothing capacitor being mounted on an insulated board fitted over the top of the relay.



Magnetic Devices impulse relay

Universal Bridge

Measurements of resistance, capacitance, inductance, power factor and Q, at 50 c/s, 1,000 c/s and, with an external source, up to 10 kc/s, can be made with the type 626 universal bridge introduced by METRIX INSTRUMENTS, LTD., 54, Victoria Road, Surbiton, Surrey. For resistance measurements, d.c. excitation is also supplied. A separate adjustable and metered d.c. supply is incorporated for the measurement of incremental inductance, and electrolytic capacitors may be measured with up to 500 V d.c. applied. The instrument includes a 1,000 c/s oscillator and selective amplifier combined with a null detector. A ring modulator allows the use of the amplifier when the bridge is d.c. excited.

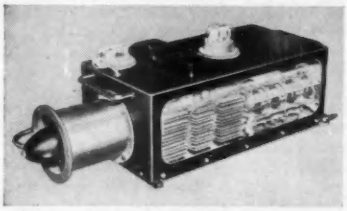


Metrix universal bridge

Facilities are provided for connection to external standards or reference components so that the instrument can be used as a comparator bridge if required. The ranges covered include resistance from 0·01 Ω to 10 MΩ, capacitance from 1 pF to 100 μF and inductance from 10 μH to 1,000 H. The instrument, which has dimensions of 20in by 9in by 15in, is suitable for operation from 110, 130, 220 or 250 V, 50/60 c/s supplies.

Aircraft Transformer-Rectifier

Direct current at 28 V for general aircraft services may be obtained from a three-phase 200 V 320-500 c/s supply by 15 kW transformer-rectifiers



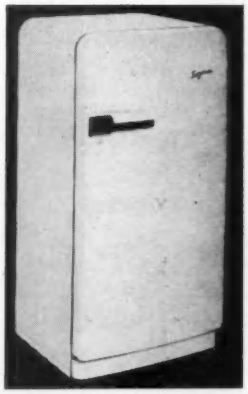
Plessey aircraft transformer-rectifier unit

introduced by the PLESSEY CO., LTD., Ilford, Essex. The units, designed for horizontal mounting and having an integral cooling fan, each have two parallel transformer-rectifier circuits giving 12-phase rectification. An interphase reactor is connected between star points to provide the positive terminal, and the rectifier heat sink provides the negative.

The unit can be used in regulated or non-regulated systems and is capable of withstanding a 40 per cent overload for two minutes without excessive temperature rise. The r.m.s. ripple voltage content of the d.c. output does not exceed 2½ per cent at a frequency 12 times that of the supply. Peaks are suppressed by capacitors connected between phases. A thermal device is incorporated in the unit to indicate excessive temperature rise. In the event of fan failure the unit can still give 25 per cent output without overheating. The equipment weighs 54 lb and measures 25in by 8in by 10in overall.

Refrigerators

The introduction of a new range of "Sigma" domestic refrigerators has been announced by ELECTRO APPLIANCES & EQUIPMENT, LTD., Regent Street, London, W.1. Three models



"Sigma" 5·8 cu ft refrigerator (Electro Appliances & Equipment, Ltd.)

are available, two table top types with capacities of 4 and 5 cu ft, and a cabinet model of 5·8 cu ft. They are made in Germany and have full-width freezer compartments; storage doors, with covered butter and cheese keepers; vegetable and salad drawers; and automatic air conditioning. All are fitted with "Danfoss-Tecumseh" hermetically sealed refrigeration units. Plastic working tops are standard equipment on the smaller models. The prices, including purchase tax in the United Kingdom, are:—63 gns (4 cu ft), 69 gns (5 cu ft) and 81 gns (5·8 cu ft).

Falco "Royalty" Cooker

It is announced by ALLIED IRONFOUNDERS, LTD., 28, Brook Street, London, W.1, that the Falco "Royalty" electric cooker, now in course of production for their Electrical Appliance Division, will be manufactured as a 4-plate model only. It has been decided not to manufacture the additional 3-plate model announced last September.

The price of the new model will be £72 9s.

Frequency Meter

The meter Type 265, recently announced by AIRMEC, LTD., High Wycombe, Bucks., measures the frequency of a repetitive waveform in the range 10 c/s to 100 kc/s to an accuracy of ±1 per cent. The input waveform is squared and limited and applied to an integrating circuit, the voltage across which is indicated on a panel meter. The meter reading is

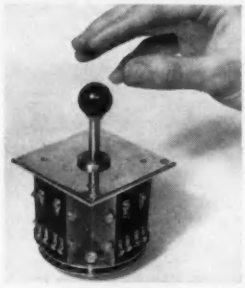
Airmec frequency meter

independent of the amplitude or waveform of the input voltage. The instrument may be used as an electronic tachometer by arranging that a shaft makes or breaks a contact at each revolution and applying an interrupted voltage to the meter. By employing an optical probe, detection of movement is carried out by reflection or interruption of a light beam, and speed measurements may be obtained without loading the equipment under test.

The meter is fully transistorised, portable, and may be powered from a.c. mains or internal batteries. Power supply and signal connection for the optical probe are available at a rear socket. An internal calibration check is provided by a stable 5 kc/s oscillator, and the meter is calibrated directly in frequency and r.p.m. An external meter or recorder may be fed from a socket on the front panel.

"Joystick" Control Switch

The range of "joystick" control switches developed by the Switch Division of PYE, LTD., Cambridge, has been extended to give manual or automatic return of the control lever from two to eight positions. A number of switches are mounted under a 3½in square chromium top plate, grouped evenly on each side of the square and operated by a lever which passes through an oil-filled spherical bearing. The directions in which the lever can be moved are controlled by a gate plate mounted below the switches, and the return to the central off position can be either spring controlled, manual or a combination of both. Controllers can be supplied with stepped switching for multi-speed control, and potentiometers can be incorporated for infinitely variable control.

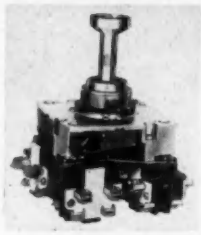


Pye "joystick" control switch

Oil-Tight Control Unit

The four-position lever operated unit designated Class 9001 Type TX "joystick" operator announced by SQUARE D, LTD., Cheney Manor, Swindon, Wilts, is a further extension of their range of oil-tight heavy duty control units. Four push-buttons are incorporated in a single unit operated in any one of four positions by a single lever, which is available as either a momentary or maintained contact operator with or without an off position latch.

A mechanism in the handle has to be depressed before the operating handle can be moved, but each handle operating position has a correspondingly numbered latch bar and, if required, individual latch bars can be



Square D oil-tight control unit

removed allowing the handle to be moved from the centre or off position to the corresponding operating position without having to depress the release pin. By moving a pin in the operating lever, the contacts can be changed from momentary to maintained.

GENERATION and DEVELOPMENT

Domestic Appliance Sales

A year ago last October, when hire-purchase restrictions were removed, there was a sharp rise in the demand for many types of electrical appliances. Since then sales have been well maintained at the higher level but the latest figures naturally show smaller

	Month ended 31st Oct.		Twelve months ended 31st Oct.	
	Total	Change %	Total	Change %
Cookers ...	31,318	+ 1·6	337,277	+ 39·8
Water Heaters:				
Immersion ...	11,653	0·0	191,435	+ 19·1
Storage ...	5,586	+12·2	59,368	+ 28·2
Wash Boilers	5,837	−26·6	70,016	− 13·3
Washing Machines ...	14,665	+60·4	174,949	+121·5
Refrigerators	8,371	+99·2	168,780	+163·2

percentage increases. Thus the Electricity Council's return covering sales by Area Boards gives the increase in the number of cookers sold in October as only 1·6 per cent compared with an average rise of 39·8 per cent for the past twelve months. The progress made, however, can be gauged by comparing the number of cookers sold last year—263,033—with the total of 337,277 in the first ten months of this year.

The largest percentage increase in October was in sales of refrigerators; nearly twice as many were sold although the figure for October, 1958, was itself 68 per cent up on the previous year.

Hinkley Point Progress

The progress which has been made at the Hinkley Point atomic power station after nearly two years' construction includes the completion of the two reactor shells and the positioning of the cooling water intake in the Bristol Channel. The 170ft long turbine hall is also well advanced. The large Goliath crane, shown in the illustration straddling No. 1 reactor, is being used to position the 90ft high heat exchangers and the heavy components of the reactor pressure vessels. This 500 MW station, being built by the English Electric-Babcock & Wilcox-Taylor Woodrow Atomic Power Construction Group, is part of the country's 6,000 MW atomic power programme, of which stations having a total capacity of 1,400 MW are already being constructed.

New Bristol Control Centre

A new distribution control centre which will help to safeguard supplies to 265,000 consumers in the South Western Electricity Board's Bristol, Bath and Weston-super-Mare Districts was officially opened at Bristol by the Lord Mayor (Councillor W. G. Cozens) on 11th December. Thermostatically controlled electric underlay heating is provided and the staff have their own mess room and all-electric kitchen. The main feature of the control room is a 70ft diagram on pale green vitrolite, treated with acid to avoid reflection, on which is represented the 2,000 miles of high-voltage mains and 2,800 substations of the local distribution system.

Protest Against Board's Decision

A dispute over the order in which electricity supplies are to be extended to parts of the Lake District is to be referred to the Electricity Council by the North Western Electricity Consultative Council. This was decided at a meeting of the Consultative Council at Manchester last week when it was reported that a letter had been received from the Electricity Board rejecting the Council's advice that the Solway coast, where 141 farms and 94 other premises were awaiting a supply, had the strongest claim and announcing that electricity would be taken instead to the Arthuret area, near Carlisle.

Mr. J. E. Harrington, chairman of the Council's North-East Lakeland Committee, said people there were very disturbed at what had happened since it had been agreed that the Solway coast area had the highest priority. The Board had always been guided by recommendations made to it in the past, but now it had departed from the policy.

Mr. A. Griffiths said the Board had an obligation and duty to the Council and had shown discourtesy in failing to explain its reasons.

A resolution was passed expressing profound dissatisfaction at the Board's decision.

Liverpool Cathedral Floodlit

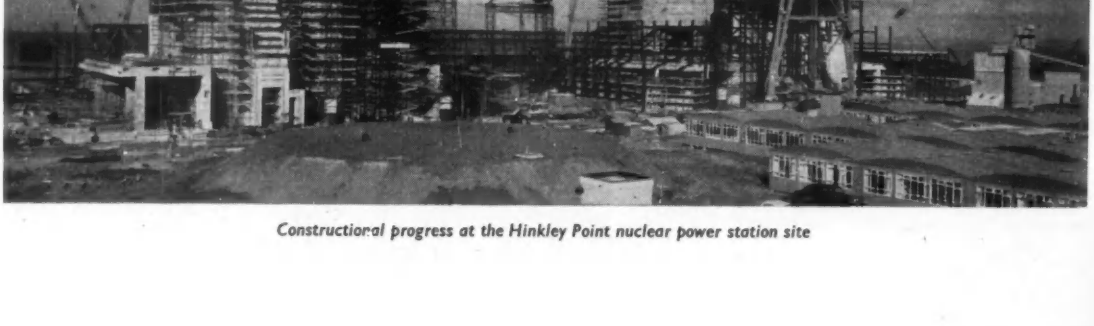
Planned and carried out by the Merseyside Electric Lighting Services Committee, as part of the golden jubilee celebrations of the Illuminating Engineering Society, the floodlighting of the 347ft tower of Liverpool Cathedral was switched on by the Lord Mayor on 6th December. Mr. P. Bregazzi (sub-area manager, Merseyside and North Wales Electricity Board), who presided at the ceremony, said this was the first time floodlighting had been used to show the beauty and dignity of the Cathedral and perhaps the experiment would influence those responsible for the building to install permanent floodlighting.

OVERSEAS

Water Turbines for Tasmania

Boving & Co., Ltd., have been awarded a contract for four 82,500 h.p. water turbines of the impulse type for the Poatina power station of

[*Continued on page 905*



Constructional progress at the Hinkley Point nuclear power station site

the Hydro-Electric Commission of Tasmania. Six turbines will eventually be installed in the station. The order includes six 36in pipeline isolating valves, as well as four turbine inlet valves, all of the Boving rotary type. The maximum operating head for the turbines will be 2,720ft, the highest head of any hydro-electric scheme in the British Commonwealth and for any turbine yet designed in Britain. The turbines will draw water from the Great Lake in the centre of Tasmania.

Peace River Project

The Peace River Power Development Co. hopes to start work on its project in northern British Columbia and the Yukon next spring. Announcing this, Mr. W. C. Mainwaring, president of the company, said that the final engineering report "indicates that it is a completely feasible project from every standpoint." But before work could begin final plans had to be approved by the Provincial Cabinet, the Provincial Government Water Controller and the Public Utilities Commission. The initial 805 MW development called for the spending of $375 million and the full plan, which would make available 3,145 MW, would cost $611 million.

Distribution in Singapore

Changes in the electricity tariff structure to benefit the poorer consumers and an accelerated programme of distribution system development were the main factors responsible for the record expansion achieved by the City of Singapore Electricity Department in 1958. The city electrical engineer (Mr. Z. K. Fiuczek, M.Sc.(Eng.), A.M.I.E.E.), in his latest report, shows that the number of new consumers connected — 7,776 — was more than twice the previous year's figure and was the highest in the Department's history. Particular attention was paid to the rural areas. Following an island-wide survey, a comprehensive scheme was prepared, divided into four stages. A Government subsidy was sought for uneconomic projects and during the year the Rural Board provided $41,705 for two schemes. Investigations were carried out into the use of catenary type plastic insulated high voltage cables for use with single-phase earth return systems and also into the relative merits of tubular steel, concrete and wooden poles for overhead lines. A further study undertaken related to the economics of overhead lines and oil-filled or gas-filled cables for a 66 kV transmission system to cater for the load at Johore Bahru and a projected satellite town.

At the end of the year the total number of consumers connected was 86,621. As a measure of the rate of progress, this may be compared with the figure of 34,053 in 1946, when the undertaking had been in existence for 40 years. Sales in 1958 totalled 492 million kWh, an increase of 54 million over the previous year. Domestic power consumption rose by 18 million kWh (13·9 per cent) and industrial power by nearly 28 million kWh (12·4 per cent).

Supplies were obtained wholly from the Department's Pasir Panjang station, where a further 25 MW turbo-alternator and two 187,500 lb/hr boilers were commissioned during the year, bringing the station up to its designed capacity of 152 MW. In anticipation of future load development a plan was prepared for adding a seventh 25 MW set and two semi-outdoor boilers. The St. James' power station has been reconstructed, the existing steam plant being dismantled. The new plant will consist of six 6 MW gas turbo-alternators supplied by 48 "free piston" gasifiers—the largest installation of its kind in the world.

The Department's accounts show that, after spending $6·4 million from revenue on capital extensions, etc., there was a net surplus of $261,914. (Straits dollar=2s 4d.)

Outside Meters in Uganda

The installation of electricity meters and associated equipment on the outside of buildings in Uganda has proved so successful that it is proposed to extend the practice. The Uganda Electricity Board introduced the system experimentally nearly three years ago and over 500 outside meters have been installed in the Kampala district alone.

Parliamentary Report

A PLEA for a speed-up of electrification in the Lake District was made in an adjournment debate by Mr. Peart, Labour member for Workington. He urged that priority should be given to the area, particularly in view of the need for amenities for tourists. This summer, because of the very dry season, he said, some of the hotels in the area in the Borrowdale Valley, which had not been electrified, had faced serious problems arising from the shortage of water because the hotels were generating their own electricity from turbines driven by waterfalls. For a long period these hotels had had to make use of oil lamps and candles, causing inconvenience not only to the hotel owners but to the guests.

The Parliamentary Secretary to the Ministry of Power, Mr. J. C. George, admitted that the Lakeland was the North Western Electricity Board's problem district. Rural electrification was costly. To a certain extent other consumers were supporting rural electrification but there was a limit to the burden they could bear. The best way to speed up rural electrification was for the consumers who were already enjoying a connection to use more electricity. The North West was in quite a good position. The number of farms connected had risen from 13,000, or 52 per cent, in March, 1948, to 21,000, or 86·3 per cent, on 30th September, 1959, compared with some 78 per cent for the country as a whole. More money was now available for the zoning scheme and the work was going ahead. The programme to date was that in Zone 42, at Frizington, the work would be finished this month. In Zone 44, Cockermouth North-West, the work which was started in October would be completed early in 1961. In Zone 47, Borrowdale, Buttermere and Loweswater, a start had been made in November and it was hoped it would be completed in mid-1961. This left one small section of the old scheme on the east side of Derwentwater, from Grange to Barrow House. The Board was making an exception in this part of Zone 46 as the plant was near the district. Work would be started in the spring and it was hoped to complete it in the summer.

Telephone Experiment

In expectation of the Post Office telephone service for cars being successful in the trial area of South Lancashire, preliminary plans are being made to extend the service to London, said the Postmaster General, Mr. J. R. Bevins. Asked about the practicability of installing radio-telephones on trains, he said this was technically feasible but very costly, and there was not enough evidence of demand to justify such expenditure.

Trade with Scandinavia

German success in selling in the Nordic markets is the result of sheer persistence in selling drive, according to a report on "U.K. Trade with Scandinavia and Finland" (price 4s), published last week by the Federation of British Industries. It summarises hitherto unpublished talks which took place last May at a series of conferences in London, Birmingham and Glasgow, between the F.B.I. and commercial representatives of British Embassies in Denmark, Norway, Sweden and Finland.

It was considered that there is too little appreciation among British firms of the size and importance of the Scandinavian markets. Because they are regarded as "easy" they receive too little attention as compared with "difficult" dollar markets. They could, however, be opened up without great difficulty by firms who took the trouble to cater for their needs. Setting up one's own subsidiary is the most satisfactory selling method and appointments of agents should be made by personal visits of top management representatives. It is recommended that every use should be made of exhibitions, advertising and market information.

Financial Section

STOCKS and SHARES

IN the industrial markets of the Stock Exchange, the moderate recoil of prices in the early part of this month proved to be no more than the precursor of a jump to new record levels. Movements are still inclined to be irregular, but the impression persists of a substantial weight of money waiting to take advantage of any material setback in quotations. In the latest advance, the revival of interest in investments on the capital equipment sides of industry was again apparent: it was encouraged by news of the increase in the steel industries' output to 95 per cent of capacity, and by some excellent annual results and dividends from the principal steel manufacturers.

Price Changes

There has been little change again in the quotations for the major electrical groups, but a continuance of the improvement of heavy engineering shares such as Babcock & Wilcox to 45s 6d, Simon-Carves to 33s 6d and Richardsons Westgarth to 12s 3d. Tube Investments at 127s 6d and Westinghouse Brake at 56s recorded gains of five and six shillings respectively. A jump of 6s 3d, to 28s 6d, in Thornycroft was accompanied by rumours of developments impending, while R. A. Lister were marked up by 7s to 55s 6d on the increase in the dividend from 12½ to 14 per cent. Duport and Desoutter showed up well, and the rise in Crabtree Electrical went further to 54s. B.I.C.C. also made ground again, reaching 56s 6d. In other sections, E.M.I. came back into favour with a rise of 4s 3d to 81s 3d, and other improvements worthy of note included those in Philips Lamps, Lucas, A. F. Bulgin, Rheostatic and Marryat & Scott.

Plessey Progress

For the record trading results achieved in 1958–9, the chairman of Plessey, Ltd., gave the credit mainly to the policy of widening the range of products, together with benefits derived from the ploughing back of profits into research and from the employment, on new developments, of additional capital raised previously. The resultant expansion in the trading profit was of the order of 60 per cent, to nearly £2¼ million, while the net surplus of £1·1 million after tax was just about double the previous year's figure. With the new capital raised in 1956 now fully engaged, the company has again increased its financial resources, to the extent of more than £4 million, by a " rights " issue of ordinary shares since the closing of the accounts in June. The object is to extend considerably the scale of operations.

Dividend Prospects

For 1958–9, Plessey distributed an interim dividend of 18 per cent, followed by a three-for-one scrip issue and a final of 7 per cent on capital so increased, the total being equivalent to 13 per cent on capital of £3·6 million. Profits were about 3¾ times the amounts paid out. In the annual report the directors reminded shareholders that

Price Changes in

Company or Board	Nom. Value	Middle price 14th Dec.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1959 High-est	1959 Low-est
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	80		3	3	3 15 0	81	77½
Brit. Elec. 1974/77	100	77		3	3	3 18 0	78	74½
Brit. Elec. 1976/79	100	80½		3½	3½	4 7 0	81	77½
Brit. Elec. 1974/79	100	91		4¼	4¼	4 13 6	91½	87½
Overseas Electric Supply								
Calcutta Elec.	£1	20/-		6·8†	7†	8 0	20/-	16/-
East African Power	£1	20/-	−6d	7½	8	8 0 0	22/6	19/3
Nigerian Elec.	£1	17/-		8	8	9 8 6	18/-	13/-
Perak Hydro-Elec.	£1	14/6		10	5	6 18 0	15/-	12/3
Electrical Shares								
Aberdare Holdings	5/-	17/9	+6d	17½	17½	4 18 6	18/9	15/6
Aerialite	1/-	8/3		54	54	6 11 0	12/3	7/9
Allen, W. H.	£1	56/3		11	12	4 5 6	56/3	43/-
Allied Insulators	5/-	23/6		—	20‡	4 5 0	23/6	18/9
Anglo-Portuguese Tel.	£1	29/-		9	9	6 4 3	30/9	26/6
Aron Elec. Ord.	£1	45/-		15	15	6 13 3	62/6	45/-
Assoc. Elec. Ord.	£1	60/-	+6d	15	15	5 0 0	67/-	53/9
Automatic Tel. & El.	5/-	21/3x.c.		17	17‡	4 0 0	21/3	18/-
Babcock & Wilcox	£1	45/6	+1/3	13¾	13	5 14 0	52/6	43/-
Bakelite	10/-	38/6	−3d	15	15	3 18 0	40/-	22/-
Baldwin, H. J.	2/-	2/6		20	—	—	3/-	2/-
Berry's Electric	5/-	33/3		10	20‡*	3 0 3	33/6	7/3
Bowthorpe Holdings	2/-	10/-		25	27	3 5 0*	10/9	8/-
British Elec. Traction:								
Def. Ord. " A "	5/-	44/6		25	35	3 18 9	47/6	35/6
B.I. Callender's	£1	56/6	+2/3	12½	13½	4 15 6	58/6	44/9
B.I. Callender's 6% Pref. ...	£1	21/-		6	6	5 14 3	21/-	19/9
British Thermostat	5/-	22/6		30	35	3 17 9*	28/-	18/6
British Vac. Cleaner	5/-	11/3	−3d	10	7½*	3 6 9	12/6	4/6
Brook Motors	10/-	56/6	−2/-	25	25*	4 8 6	59/6	46/-
Bulgin, A. F.	1/-	12/9	+9d	45	50	3 18 6	12/9	6/9
Bulpitts	5/-	19/6		—	15	3 17 0	19/6	10/-
Burco Dean	5/-	19/6	+1/-	22½	16*	4 2 0	19/6	12/3
Cable & Wireless:								
Ord.	5/-	17/9		10	10*	2 16 3	18/6	12/3
4% Loan	100	94		4	4	4 5 0	96	93
Chloride El. Storage " A " ...	£1	65/-	−6d	17½	20‡	4 2 0*	72/-	43/8
Clarke Chapman	£1	55/-		27½	13¾*	5 0 0	66/3	52/6
Cole, E. K....	5/-	26/6	+1/3	17½	20	3 15 6	26/6	17/3
Contactor Switchgear	5/-	14/9		14	14	4 15 0	16/9	12/-
Cossor, A. C.	5/-	7/3		Nil	5	3 9 0	9/-	6/3
Crabtree	10/-	54/-	+1/-	20	20	3 14 0	54/-	28/-
Crompton Parkinson	5/-	17/6		12	14	4 0 0	19/-	11/9
Davis & Timmins	5/-	21/9		18	20	4 12 0	22/-	14/6
De La Rue	10/-	67/6	+1/-	17½	20	2 19 3	67/6	30/3
Decca " A "	10/-	47/6	+6/3	50	20*	4 4 3	46/3	33/3
Desoutter	5/-	37/-	+3/3	25	21¾*	2 18 9	37/-	19/-
Dewhurst	2/-	9/6	+6d	20	20	4 4 3	9/6	7/3
Dictograph Tel.	2/-	11/6	+3d	20	20	3 9 6	11/6	7/-
Dubilier Condenser	1/-	5/3		20	25	4 15 3	5/6	3/3
Duport	5/-	23/6	+1/9	12½	17½	3 14 6	23/6	10/3
E.M.I.	10/-	81/3	+4/3	15	20*	2 9 3	84/-	48/-
Electrical Apparatus	5/-	14/-		14½	14½	5 3 0	16/6	13/-
Electrical Components	5/-	13/3		12½	15	3 15 6*	14/-	7/-
Elec. Construction	£1	35/-		8½	9	5 2 9	37/-	27/9
Elliott-Automation	5/-	26/3	+9d	—	11·2‡	2 2 9	30/6	16/9
Enfield Rolling Mills	£1	54/9	+1/9	12½	15	5 12 3	60/-	36/9
English Electric	£1	45/9	−6d	14	14	4 1 9*	48/9	37/10
English Electric 3½% Pref. ...	£1	13/6		3½	3½	5 11 0	13/6	12/3
Ericsson Tel.	5/-	25/6		12†	13†	4 3 6	28/-	22/3
Ever Ready	5/-	25/-	+1/-	20	27½‡	3 6 0*	28/-	13/3
Falk Stadelmann	£1	35/-	−6d	10	10	5 14 3	35/6	25/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

the policy is to take interim and final dividend decisions on the results of the relevant six months, so that unless either an improvement or deterioration in trading conditions gives cause for a change, any dividend declared is likely to be followed by another at the same rate. In the market it is consequently regarded as fair to value the shares in relation to a dividend of 14 per cent (double the rate of the latest payment) despite the fact that capital has now been raised to £5·4 million by the new issue. In the annual report the chairman said that the group had been very busy since the end of the financial year in June, and particularly since the General Election.

Electrical Investments

Company or Board	Nom. Value	Middle price 14th Dec.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1959 Highest	1959 Lowest
Electrical Shares—continued								
G.E.C.	£1	43/-	−6d	10	10	4 13 0	48/-	31/3
G.E.C. 6½% Pref.	£1	23/-		6½	6½	5 13 0	23/-	20/3
General Cables	5/-	9/-		24	15	8 6 9	9/3	7/6
Greenwood & Batley	£1	116/3		20	20	5 3 3	117/6	75/-
Hackbridge Holdings	5/-	16/3	+6d	20	20	6 3 0	19/3	14/3
Hackbridge & Hewittic	5/-	14/3		20	20	5 5 3*	15/6	10/6
Head Wrightson	5/-	25/-	+2/-	20	14‡*	2 16 0	26/-	16/6
Heatrae	2/-	9/6		20	20	4 4 3	10/-	7/6
Holophane	5/-	18/9		22½	26	6 18 9	20/-	14/9
Hoover	5/-	95/6		50	60	3 2 9	98/9	55/-
I.C.I.	£1	56/6	+2/3	12	8*	2 16 9	58/9	33/-
Intl. Combustion	5/-	38/9		25	30‡	3 17 6	39/-	29/9
Intl. Computers & T.	£1	71/3		—	8‡	2 5 0	78/9	57/6
Johnson & Phillips	£1	18/9		5	5	5 6 9	30/6	18/3
Lancashire Dynamo	£1	46/3	−9d	11	12½‡	4 1 6*	48/9	31/6
Laurence Scott	5/-	18/-		15	15	3 11 6*	18/9	14/-
Lister, R. A.	£1	55/6	+7/-	12½	14	5 0 9	55/6	32/9
Lucas, J.	£1	70/6	+5/3	10	12½	3 11 0	70/6	43/3
Marconi Marine	£1	42/-		10	10	4 15 3	48/6	40/-
Marryat & Scott	2/-	13/3	+9d	37½	22½*	3 8 0	13/6	8/6
Mather & Platt	£1	51/-	+1/-	15	10‡*	4 2 3	51/6	41/3
Metal Industries	£1	69/6	−6d	14	15‡	4 6 3	71/3	39/9
Midland Elec. Mfg.	£1	51/3	+1/3	12½	10*	3 18 0	51/3	41/6
Morphy-Richards	4/-	32/9	+3d	20	25	3 1 0	34/-	18/-
Murex	£1	64/-	+1/6	17½	15	4 13 9	64/-	42/-
Newman Ind.	2/-	3/6		10	10	5 14 3	3/6	2/3
Oldham & Son	1/-	2/9	−3d	17½	17½	6 7 3	3/3	2/6
Parsons, C. A.	£1	55/-	+6d	7½	8½‡	2 19 0	58/-	45/9
Philips' Lamps	Fl.10	158/9	+16/3	14	14	1 13 6	160/-	88/-
Plessey	10/-	45/-	+2/6	20	14*‡	3 2 3	46/3	23/6
Pye	5/-	18/3x.c.		12½	12½*‡	3 8 6	20/6	13/-
Pyrotenax	5/-	44/9		—	34	3 16 0	47/6	33/9
Radiation	£1	39/6		5	6	3 0 9	39/9	24/9
Reliance Clifton	5/-	22/6		15	15	3 6 9	24/6	17/6
Reyrolle	£1	95/6	+1/-	17½	17½	3 13 3	98/-	85/9
Rheostatic	4/-	15/-	+1/9	12½	12½	3 6 9	15/-	8/3
Richardsons Westgarth	10/-	12/3	+9d	8½	8½	6 16 0	15/3	11/6
Simon-Carves	5/-	33/6	+1/-	25	25	3 14 9	33/6	28/6
Smith (England), S.	4/-	18/3	+3d	12½	17½	3 16 9	21/-	11/6
Southern Areas	£1	14/6		Nil	Nil	Nil	15/-	10/6
Strand Elec.	5/-	17/9		15	20	5 12 9	18/-	8/6
Sturtevant	5/-	22/6		15†	15†	5 9 0	23/6	17/-
Sun Elec.	5/-	15/9x.d.		25	15*	4 15 3	16/9	8/3
Switchgear & Cowans	5/-	15/6		22½	15*	4 16 9	16/-	10/3
T.C.C.	10/-	57/6		25	25	4 7 0	58/6	38/-
Telephone Mfg.	5/-	6/3	+3d	10	10	8 0 0	7/3	4/9
Telephone Rentals	5/-	19/-		12½	12½*	3 5 9	22/6	11/9
Thompson (John)	5/-	21/6	+9d	25	25	5 16 3	25/6	19/6
Thorn Elec.	5/-	48/9		17½	20	2 1 0	50/-	26/3
Thornycroft	£1	28/6	+6/3	7½	6	4 4 3	30/-	20/6
Tube Investments	£1	127/6	+5/-	17½	20	3 2 9	127/6	71/6
Vactric	5/-	43/-	+2/9	25	37½	4 7 3	46/6	26/3
Veritys	5/-	1/6		2½	—	—	5/-	1/3
Walsall Conduits	4/-	14/9		22½	22½	3 9 3*	15/3	10/8
Ward & Goldstone	5/-	55/6		25	30	2 14 0	57/6	30/6
Watford	2/-	11/6		25	25*	4 7 0	14/9	7/6
Westinghouse	£1	56/-	+6/-	10	10	3 11 6	56/6	39/6
West, Allen	5/-	13/9		12½	11§*	4 5 0	14/6	11/9
Wolf Electric	5/-	9/6		10	10	5 5 3	9/9	7/9

Pye Issue

Pye 5s shares are now quoted ex the 10 per cent scrip issue and stand at about 18s 3d. This is the second capital operation of the current financial year (which ends in March), the first having been the "rights" offer of about 6½ million new shares at a price of 13s in July. Issued ordinary capital now ranking for dividends has consequently been increased from approximately £3·1 to £5·2 million. On the subject of future dividend prospects, the directors have advised shareholders that profit figures for the first six months of the present period were well in advance of those for the same half of the previous year, and very much better than had been estimated. They were accordingly confident that it would be possible, in the absence of unexpected developments, to maintain the rate of dividend at the prevailing rate of 12½ per cent on capital as increased by both the cash and the scrip issues. This assumption gives a prospective yield of 3½ per cent.

Company News

After a slow initial reaction to the announcement of the company's annual results, Decca shares gathered considerable strength after further consideration of the 12 per cent improvement reported in trading profits for 1958–9 and the intimation that in the current year (of which eight months have already run) turnover has again been substantially higher. There is no effective change this time in the dividend at 20 per cent, on the basis of which the 10s ordinary shares at 53s 6d show a yield of 3¾ per cent, and the "A" (non-voting) shares at 47s 6d of 4¼ per cent. Brook Motors 10s shares have been quoted lower at 56s 6d since the report of a contraction of profits (before tax) from £829,000 to £572,000 in the year ended last September. The dividend of 25 per cent for the year represents a small improvement on the previous payment, and gives a yield of about 4½ per cent on the shares at their present price.

S. Smith & Sons Prospects

This year's profits of S. Smith & Son (England), whose annual meeting was held earlier this month, are expected to fall somewhat below the record figures returned for 1958–9. In his review the chairman anticipated that the increase in earnings from the sides of the business concerned with motor vehicle equipment, and also with timing and control devices, would not fully offset the contraction in prospect for aviation products. The price of the 4s ordinary shares has shed a shilling or so of the previous big rise, and at 18s 3d gives a yield of 3¾ per cent from the 17½ per cent dividend.

REPORTS and DIVIDENDS

Contactor Switchgear, Ltd.—The annual meeting was held on 9th December, Mr. H. Rayner (chairman) presiding. In his statement, which had been previously circulated, the chairman said that for engineering companies whose main market was for capital goods the year had not been an easy one. Competition had been severe and was likely to continue, and this had had an effect on profits. The output from the works had again been a record and there was an improving tendency in the value of orders coming in. This, with the orders in hand, should keep the plant fully occupied in the current financial year.

Brook Motors, Ltd.—The group profit for the year ended 30th September last was £572,436, as compared with £829,481 for the preceding year. A sum of £274,779 is set aside for taxation. It is proposed to pay a final dividend of 20 per cent, making 25 per cent for the year (unchanged) on larger capital.

Following the annual meeting on 23rd January an extraordinary meeting will be held to consider a resolution to apply £144,136 10s, part of the amount standing to the credit of share premium account, in paying up in full 288,273 ordinary shares of 10s each, to be allotted credited as fully paid to ordinary shareholders in the proportion of one new share for every six ordinary shares held. The new shares will rank *pari passu* with the existing ordinary shares, except that they will not participate in the final dividend now recommended.

English Telephone Co., Ltd.—At a general meeting of the company held on 9th December a resolution was passed increasing the nominal capital to £100,000. The issued capital, fully paid, is £50,000.

Solus Teoranta.—The net profit of this Irish lamp-making concern for the year ended 30th June last is £1,115, as compared with £2,774 for 1957-58. The dividend for the year is maintained at 5 per cent and £4,695 is carried forward (against £11,484 brought in).

George Kent, Ltd., have announced an interim dividend of 5 per cent (unchanged) on capital increased by other than a scrip issue.

Head, Wrightson & Co., Ltd., are paying an interim dividend of 4 per cent (against an equivalent of 3½ per cent after allowing for a scrip issue).

Aiton & Co., Ltd., have declared an interim dividend of 4 per cent (unchanged).

New Companies

De Laval Ljungstrom (Great Britain), Ltd.—Registered 27th November. Capital £5,000. To act as representatives of Turbin Aktiebolaget de Laval Ljungstrom in the United Kingdom and any other part of the world, etc., to carry on the business of agents for the import, export, purchase and sale of turbine plant, marine turbines and electrical and general engineering components of all kinds, etc. Directors: E. R. Durham, Dr. I. K. E. Jung, C. R. Nicolin and A. C. Von Sydow. Regd. office: 6, Bloomsbury Square, W.C.1.

Harold Palfreyman, Ltd.—Registered 26th November. Capital £3,000. To acquire the business of an electrical engineer carried on by H. Palfreyman at Hanley, Stoke-on-Trent, etc. Directors: H. Palfreyman (chairman) and R. D. Taylor. Regd. office: 8, Northwood Park Road, Stoke-on-Trent.

E.P.N. Electrical Co., Ltd.—Registered 26th November. Capital £3,000. To acquire the business of electric motor winding and repairs carried on by H. Goodyear at Birmingham as E.P.N. Electrical Co., etc. Directors: H. Goodyear and G. D. Jones. Regd. office: 801, Warwick Road, Birmingham, 11.

Tarr & Sons, Ltd.—Registered 18th November. Capital £1,000. Dealers in and agents for domestic electrical and electronic equipment including vacuum cleaners, scrubbers, polishers, etc. Directors: G. Tarr and Mrs. Matilda Tarr. Regd. office: 2, Bentinck Street, W.1.

Modern Electric (Bognor Regis), Ltd.—Registered 23rd November. Capital £200. Manufacturers of and dealers in electrical goods of all kinds, radio and television sets, etc. Directors: P. E. Wilkins and Erica M. Wilkins. Regd. office: 72e, High Street, Bognor Regis.

L. & T. Bosher, Ltd.—Registered 17th November. Capital £100. Manufacturers of and dealers in electrical equipment, apparatus, etc. Directors: T. G. Bosher, Mrs. Brenda Bosher, L. T. Bosher, Mrs. L. Bosher and W. Bosher. Regd. office: 67, High Street, Lees, Oldham.

Lewcol Electrics, Ltd.—Registered 18th November. Capital £100. Manufacturers, sellers, importers and exporters of and dealers in electrical, radio, telephone and telegraph apparatus, etc. Solicitors: Stannard & Moss, Cheltenham.

C. H. Seymour, Ltd.—Registered 23rd November. Capital £5,000. Designers, manufacturers of and dealers in electrical, radio and television sets, etc. Directors: C. H. Seymour and Mrs. Joan K. M. Seymour. Regd. office: 24, Sutton Park Road, Seaford.

Corrigan Electrical Co., Ltd.—Registered 23rd November. Capital £100. Electricians, etc. Solicitor: F. L. J. Munday, Orpington.

D. H. Marrion, Ltd.—Registered 23rd November. Capital £1,000. To acquire the business of electrical contractors carried on by D. H. Marrion at Barnsley, etc. Directors: D. H. Marrion and Mrs. Gladys Marrion. Regd. office: 220, Sheffield Road, Barnsley.

Instrument Accessories, Ltd.—Registered 25th November. Capital £200. Electrical engineers and contractors, etc. Directors: R. K. Holt, Diane H. Holt and Maureen A. Quittner. Regd. office: 5, Tilney Road, Southall, Middlesex.

Turntable (Erith), Ltd.—Registered 27th November. Capital £100. Manufacturers of and dealers in radio, electrical and mechanical apparatus of all kinds, etc. Directors: T. P. Fleming and Mrs. Mollie E. Fleming. Regd. office: 18, Pier Road, Erith.

H. F. Sheldrake, Ltd.—Registered 26th November. Capital £2,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: H. F. Sheldrake and Mrs. Margaret A. Sheldrake. Regd. office: 18, Bywood Avenue, Shirley, Surrey.

Bankruptcies

G. G. Short, 39, Grange Farm, Whitehall Road, Colchester, electronics engineer, lately carrying on business as a manufacturing electronics engineer at John Street, Market Rasen, Lincs.—Receiving order made 30th November on debtor's own petition.

F. C. Summers, a partner in the firm of Conway Electrics of 775, Great Cambridge Road, Enfield, Middx., and lately carrying on business at 38, Philip Lane, Tottenham, London, N.15, electrical engineer.—Receiving order made 1st December on a creditor's petition.

C. F. Thompson, lately carrying on business at 8, Victoria Road, Rushden, and at 16, Denmark Road, Rushden, Northants., electrical engineer.—Public examination 8th January at the County Hall, Northampton.

C. W. A. Hales, lately carrying on business at Robden, Hoyal Road, Hamworthy, Poole, and at 2, Lake Road, Hamworthy, Poole, Dorset, as an electrical engineer.—Last day for receiving proofs for dividend 22nd December. Trustee, Mr. G. E. Radford, 12, Portland Street, Southampton.

A. Moore, lately carrying on business at 5, Upper Hurst, Mount, Outlane, Huddersfield, and 12, Ray Gate, Mount, Outlane, Huddersfield, as a builder, contractor and electrician.—First and final dividend of 4s 2d in the £, payable at 27, Bradford Road, Brighouse.

G. F. Hedger, 80, Grenville Road, Plymouth, trading as Hedger and Greenway, electrical contractors, formerly carrying on business in partnership with another at that address.—First dividend of 3s 6d in the £, payable at 50, The Terrace, Torquay.

D. W. Damms, electrical contractor, 181, Wellington Street, Grimsby.—Receiving order made 2nd December on debtor's own petition.

FORTHCOMING EVENTS

MOST of the Institutions and Societies will be suspending their deliberations from now until the New Year as members will be otherwise engaged during the festive season. There are, however, one or two events which readers may wish to note. The Institution of Electrical Engineers has arranged a Christmas holiday lecture for older school children at the Institution, Savoy Place, W.C.2, on the afternoons of 30th and 31st December. The subject is "Colour Television," and the lecturer is Mr. G. G. Gouriet, M.I.E.E. All tickets for the afternoon lectures have already been disposed of, and Mr. Gouriet has therefore agreed to repeat the lecture on the morning of 31st December (10.30 a.m.). Applications for tickets for this additional lecture should be made to the Institution.

The North Western Centre of the I.E.E. has also arranged a Christmas holiday lecture for older school children. Here again the subject is "Colour Television," and the lecturer will be Dr. Ing. R. Feinberg. It will be given as follows:—29th December (3 p.m.) at Bolton Technical College; 5th January (3 p.m.) at the Manchester College of Science and Technology; 9th January (3 p.m.) at Peel Park Technical College, Salford.

For the first time, the London Graduate and Student Sections of the I.E.E., the I.C.E. and I.Mech.E. are combining to hold a New Year's Eve dinner-dance. This will be held at Bucklersbury House, E.C.4.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2

1946

15575. Szilard, L., and Fermi, E.—Gas cooled nuclear reactor. 22nd May, 1946. (825521.)

1953

32165. Fairey Aviation Co., Ltd.—Thermionic valve circuit for multiplying two quantities. 22nd March, 1955. (825275.) 32166. Radio frequency pulse receivers. 21st March, 1955. (825276.)

1954

3859. Fairey Aviation Co., Ltd.—Phase sensitive electric circuits. 9th June, 1955. (825280.)

1955

7137. British Aluminium Co., Ltd.—Electrolytic three-layer cells for the refining of aluminium. 9th March, 1956. (825443.)

8213. Fairey Aviation Co., Ltd.—Electrical impedances. 21st June, 1956. (825277.) 8214. Thermionic valve circuits. 21st June, 1956. (825278.) 8215. Gain control and modulation correcting circuits. 21st June, 1956. (825279.)

25365. Minister of Supply.—Radiating waveguide feeders for radio-frequency electromagnetic waves. 30th November, 1956. (825532.)

31379. General Electric Co.—Split-phase electric motors. 2nd November, 1955. (825624.)

31802. S.E. Laboratories, Ltd.—Solenoid operated valves. 7th November, 1956. (825363.)

1956

1745. British Insulated Callender's Cables, Ltd.—Annealing of non-ferrous wire. 17th January, 1957. (825539.) 1746. Metal spools for carrying wire. 17th January, 1957. (825540.)

2496/7. General Electric Co.—Travelling wave tubes. 25th January, 1956. (825545/6.)

3659. Holzer, W.—Time switch with magnetic eddy current brake for washing machines and rinsing machines. 6th February, 1956. (825453.)

5509. Pye, Ltd.—Television picture reproducing apparatus. 21st February, 1957. (825455.)

6001. Vedder G.m.b.H. Geb.—Electric switches. 27th February, 1956. (825456.)

6165. Cirot, A.—Electric illuminating device. 28th February, 1956. (825370.)

7073. General Electric Co., Ltd.—Electrolytic coating of magnesium and magnesium alloys by anodic treatment. 21st February, 1957. (825458.)

11015. Philips Electrical Industries, Ltd.—Seals for containers. 11th April, 1956. (825636.)

11661. Elektrochemisches Kombinat Bitterfeld Veb.—Electrolytic decomposition cell. 17th April, 1956. (825374.)

19698. Hill, J. W.—Electrical engraving machines. 26th June, 1957. (825605.)

23149. General Electric Co.—Magnetrons. 26th July, 1956. (825565.)

23701. Sperry Rand Corporation.—Radio frequency pulse generators. 1st August, 1956. (825644.)

24136. Vogel, P.—Apparatus for the manipulation of radioactive materials. 7th August, 1956. (825645.)

28698. Texas Instruments, Inc.—Method of manufacturing electrical semiconductor devices. 19th September, 1956. (825654.)

29132. Sunvic Controls, Ltd.—Thermally operated electric switch devices. 18th September, 1957. (825542.)

32623. Oxley, R. F.—Methods of manufacture of electrodes for adjustable rotary condensers and electrode units manufactured thereby. 8th October, 1957. (Cognate application 18064, 6th June, 1957.) (825656.)

34847. Sperry Rand Corporation.—Circuit board wiring techniques. 14th November, 1956. (825658.)

38888. Siemens-Schuckertwerke A.G.—Noise suppression means for dry shaving devices. 20th December, 1956. (825518.)

1957

872. A.E.I.-John Thompson Nuclear Energy Co., Ltd.—Nuclear reactors. 1st January, 1958. (825662.)

2828. Messen-Jaschin, G.—Electrostatic precipitators. 25th January, 1957. (825666.)

3041/2. Rolls-Royce, Ltd.—Plug and socket type electrical connectors. 28th January, 1958. (825579/80.)

3992. General Mills, Inc.—Production of soldered joints on circuit carrying panels. 5th February, 1957. (825297.)

4183. Gloster Aircraft Co., Ltd.—Diaphragm operated electric switches. 6th May, 1958. (825519.)

4306. Coq N.V.—Gas blast circuit-breakers. 7th February, 1957. (825678.)

5379. Electric Storage Battery Co.—Counter electric motive force cells. 18th February, 1957. (825667.) 5383. Electric storage batteries. 18th February, 1957. (825481.)

5907. General Electric Co., Ltd.—Glass compositions. 14th May, 1958. (825435.)

10751. General Electric Co.—Magnetrons. 2nd April, 1957. (825566.)

10792. Accumulatoren-Fabrik A.G.—Alkaline electric accumulator. 2nd April, 1957. (825486.)

11981. Plessey Co., Ltd.—Resistor tracks, more particularly terminal connections therefor. 11th April, 1958. (825489.)

18783. Automatic Telephone & Electric Co., Ltd.—Emergency signalling arrangements. 4th June, 1958. (825720.)

19515. United Kingdom Atomic Energy Authority.—Spark-gap circuits. 19th June, 1958. (826071.)

19807. Svenska Turbin Aktiebolaget Ljungström.—Radial flow elastic fluid turbines. 24th June, 1957. (825894.)

20309. Marconi's Wireless Telegraph Co.—Television signal and like fader devices. 21st February, 1958. (825793.)

22795. Amp, Inc.—Tool for cutting a braided conductor. 18th July, 1957. (825983.)

25577. General Electric Co., Ltd.—Electric circuit arrangements incorporating cathode-ray tubes. 12th August, 1958. (825898.)

27089. Tesla, Narodni Podnik.—Negative feedback amplifiers. 28th August, 1957. (825988.)

29304. Ericsson Telephones, Ltd.—Enclosed spark gaps. 15th August, 1958. (825899.)

29630. Standard Telephones & Cables, Ltd.—Omnirange beacon antennæ. 20th September, 1957. (825993.)

30826. General Motors Corporation.—Method of interconnecting an aluminium terminal member to an aluminium capacitor foil member. 2nd October, 1957. (825900.)

32126. Standard Telephones & Cables, Ltd. (Lorenz A.G., C.).—Circuit arrangement for protecting transistor end stages from overheating, and means for preventing the overloading of the transistors. 15th October, 1957. (825802.)

32641. Diamond Alkali Co.—Carbon electrodes. 18th October, 1957. (826084.)

33446. Stiebel, T. H.—Electrically heated hot water heaters and storage tanks. 25th October, 1957. (825732.)

34337. Sperry Rand Corporation.—Coil-winding machines. 4th November, 1957. (825804.)

38620. Allmänna Svenska Elektriska A.B.—Magnetic amplifiers with negative feedback. 12th December, 1957. (825999.)

38653. English Electric Valve Co., Ltd.—Microwave amplifiers. 19th August, 1958. (826090.)

1958

2450. Det Store Nordiske Telegrafselskab A.S.—Telegraph apparatus. 24th January, 1958. (826100.)

3487. Compagnie Générale de Télégraphie sans Fil.—Manufacture of semiconductor devices. 3rd February, 1958. (825905.)

3851. Babcock & Wilcox Co.—Bottom-supported tubulous vapour generators. 6th February, 1958. (825811.)

17865. Philips Electrical Industries, Ltd.—Methods of manufacturing electrically insulating panels having a conductive pattern and panels manufactured by such methods. 4th June, 1958. (826117.)

19605. Electrolux Corporation.—Turbine driven floor tool for vacuum cleaners. 19th June, 1958. (826119.)

30048. Philips' Gloeilampenfabriken N.V.—Electric coffee mills. 19th September, 1958. (826120.)

40303. S. & C. Electric Co.—Gas-blast electric circuit interrupters. 7th January, 1957. (Divided out of 825913.) (825914.)

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 2nd January:—

Mozart. No. 786,044. Class 9. Sound amplifiers, loudspeakers and tuners (being parts of sound reproducing apparatus).—Pye, Ltd., Radio Works, St. Andrews Road, Cambridge.

Cinecorder. No. 791,408. Class 9. Apparatus and instruments for recording and reproducing sound.—K. G. M. Electronics, Ltd., The Barons, St. Margarets, Twickenham, Middx.

Varilux. No. 787,993. Class 9. Scientific and electrical apparatus and instruments; nautical geodetic, photographic, cinematographic, optical, weighing, measuring, signalling, checking (supervision), life-saving and teaching apparatus, etc.—Société Industrielle et Commerciale des Ouvriers Lunetiers (Cottet, Poichet, Tagnon & Cie.), Paris, France. Address for service, c/o Marks & Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2.

Caby. No. B791,999. Class 9. Electrical and electronic instruments and apparatus; and meters.—Household Electrix, Ltd., 47-49, High Street, Kingston-on-Thames.

Lautrec. No. 793,200. Class 9. Radio receivers and sound reproducing apparatus and instruments.—Blazy & Clement, Ltd., 137, Regent Street, London, W.1.

Issella. No. 793,375. Class 9. Electric vacuum cleaners, adding machines and calculating machines.—Issella (Developments), Ltd., 93, Black Lion Lane, Hammersmith, London, W.6.

Siera No. 789,971. Class 11. Electric lighting installations, lamps, head-lamps; refrigerators, toasters, electric stoves, ovens, kitchen ranges, electric heating apparatus, milk boilers, pressure cookers, water heaters, boilers (not being parts of machines); fans; hair drying apparatus; fires, immersion heaters, radiators, hotplates, etc.—N.V. Siera Radio, The Hague, Holland. Address for service, c/o T. D. Threadgold, Century House, Shaftesbury Avenue, London, W.C.2.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Australia.—Stores and Contracts, Postmaster General's Department, Melbourne. 14th January. Telephone parts. (E.S.B. 28716/59. Ten/43805.)* 19th January. Switch apparatus and maintenance parts. (E.S.B. 28717/59. Ten/43793.)* Resistance wire. (E.S.B. 28718/59. Ten/43804.)*

Electricity Commission of New South Wales, Sydney. 11th January. 100/200 kV, 100 kVA testing transformer and associated r.m.s. and peak reading voltmeters. (E.S.B. 28576/59. Ten/43796.)*

Brisbane City Council. 5th February. 110 kV outdoor switchgear for Tennyson power station. (E.S.B. 28611/59. Ten/43788.)* 26th February. One 72 MVA and one 30 MVA oil-immersed transformers with spare parts. (E.S.B. 28612/59. Ten/43742.)*

Blackpool.—Corporation. 2nd January. Electric lamps for the year ending 31st March, 1961. (See this issue.)

Burma.—Executive Officer, Rangoon Electric Supply. 31st December. Electric stores, including lamps, fluorescent lighting fittings, lampholders, switches, domestic electrical appliances, radio sets, etc. (E.S.B. 28936/59. Ten/43831.)*

Camberwell.—Borough Council. 8th January. Electric lamps (Schedule K), and electric cables, conduit and fittings (Schedule S), for period contracts. Borough engineer and surveyor, Town Hall, Camberwell, S.E.5.

Camborne-Redruth.—U.D.C. 23rd January. Electrical equipment and fittings (Schedule 24), for the year ending 31st March, 1961. S. C. Wilson, clerk, Council Offices, Camborne.

Canada.—Winnipeg Hydro-Electric System. 23rd December. Supervisory control equipment. (E.S.B. 28671/59. Ten/43798.)*

Saskatchewan Power Corporation, Regina. 15th January. Electrical materials for the year 1960. (E.S.B. 29083/59. Ten/43885.)*

Cardiff.—Welsh College of Advanced Technology. 16th January. Equipment for h.v. laboratory.

Ceylon.—Tender Board, Ministry of Agriculture and Lands, Colombo. 22nd December. Two heavy duty electric vehicle lifts. (E.S.B. 28626/59. Ten/43772.)*

Cornwall.—County Council. Fixed price tenders for electrical services at Launceston College extensions. (See this issue.)

Dagenham.—Borough Council. 9th January. Electric lamps (Schedule 31), for the year ending 31st March, 1961. Borough engineer and surveyor, Civic Centre.

Hereford.—Corporation. 28th December. Electrical installations in 14 aged persons' bungalows. (See this issue.)

India.—Madras State Electricity Board. 29th December. A.c.s.r. earth wire and accessories. (E.S.B. 28799/59. Ten/43826.)*

Director-General, India Stores Department. 11th February. Electric annealing furnace. (See this issue.)

Iraq.—Directorate General of Water and Electricity, Baghdad. 26th December. Transformers. (E.S.B. 28984/59. Ten/43851.)*

Kingston-on-Thames.—Corporation. 19th January. Wiring for electric lighting of fifty-eight market stalls. (See this issue.)

Korea.—Government Office of Supply, Seoul. 7th January. Telephone exchange equipment and iron and steel piping. (E.S.B. 28594/59/I.C.A. Ten/43748.)*

Leeds.—City Council. 1st January. Electrically driven automatic booster pumping plant, complete with switchgear, motors, time controls, etc., York Road redevelopment area. K. L. Forster, general manager and engineer, Civic Hall, 1.

New Zealand.—G.P.O., Wellington. 20th January. Telephone cable. (E.S.B. 28706/59. Ten/43803.)*

Nigeria.—Electricity Corporation of Nigeria. 20th January. Electricity meters. (See this issue.)

Pakistan.—Government Department of Supply and Development, Karachi. 31st December. Muffle furnace unit and electric arc furnace. (E.S.B. 29073/59. Ten/43888.)*

Portuguese East Africa.—Ports, Railways and Transport Department, Lourenço Marques. 29th February. One 85 kVA generating set. (E.S.B. 28910/59. Ten/43842.)*

Rhodesia and Nyasaland.—Federal Tender Board, Causeway. 8th January. Thermostatically controlled high pressure sterilisers. (E.S.B. 28534/59. Ten/43756.)*

St. Austell.—U.D.C. 18th January. Three vertical spindle unchokeable centrifugal pumps, complete with electric motors, starters, wiring and equipment, for Mevagissey sewerage. H. G. King, engineer and surveyor, Municipal Offices, Truro Road.

Stafford.—Stafford College of Technology. Manufacturers are invited to apply to the Principal for specifications for rotating electrical machinery and also to submit proposals for equipment for new laboratories. (See this issue.)

Sudan.—Sudan Gezira Board, Barakat. 10th January. Three 55 h.p. motors and starters. (E.S.B. 28865/59. Ten/43789.)*

Sunderland.—Corporation. 7th January. Electrical installations in 206 dwellings. (See this issue.)

ORDERS PLACED

Dewsbury.—Corporation Corporate Property Committee. Installation of electrical services in connection with alterations at the Town Hall (£2,922).—Hammerton & Waring.

Glasgow.—Corporation Education Committee. Electrical installation, including space heating, at primary school, Broomhill (£7,536).—Archibald Watson & Dundas.

Wallasey.—Corporation Housing Committee. Electrical installation work in flats, etc., at Church Street (£3,791).—F. H. Ashworth.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Alnwick.—Proposed factories on new trading estate for Hardy Brothers, Alnwick, and the Union International Co., 13, West Smithfield, London, E.C.1, and creamery for the Co-operative Wholesale Society, Ltd., 1, Ballom Street, Manchester.

Bath.—Houses (122), Twerton/Whiteway estate; city planning officer, 7, North Parade Buildings.

Bedlington.—Council offices; U.D.C. surveyor.

Berkhamsted.—Health centre, Victory Road; Woodroffe, Buchanan & Coulter, architects, 5, Bedford Row, London, W.C.1.

Bristol.—Flats and maisonnettes (100), with two laundries, Redcliff; Richard Costain, Ltd., Brunel House, St. George's Road.

Burton-on-Trent.—Houses (150), Edge Hill estate; borough architect, Town Hall.

Dewsbury.—New technical and art college (£500,000); West Riding county architect, Westfield Road, Wakefield.

Doncaster.—Museum and art gallery, Chequer Road; P. P. Taylor, Ltd., 6, South Parade.

Dorchester.—Development of 36-acre housing estate; Comben & Wakeling, Ltd., Kingsbury Circle, N.W.9.

Enfield.—Works extensions; Ripaults, Ltd., Southbury Road.

Eston.—Flats and maisonnettes (88), Grangetown and South Bank; N. C. Harrison, U.D.C. surveyor.

Ipswich.—Three-storey offices, Princes Street (£460,000) for City Centre Properties, Ltd.; Cotton, Ballard & Blow, architects, Cavendish House, Waterloo Street, Birmingham, 2.

Fire station and administrative headquarters, Colchester Road (£178,300); Johns, Slater & Haward, architects, 32, Foundation Street.

Leicester.—Civic theatre proposed on the Regent Street/Princess Road site (about £300,000); city architect, 7, Newarke Street.

Liverpool.—Casualty, admission and physiotherapy departments, Walton Hospital; R. Costain & Sons, Ltd., Barlow Lane.

London.—Rebuilding St. Katherine's Church, Eugenia Road, Bermondsey; Covell & Matthews, architects, 34, Sackville Street, W.1.

Office block, Baker Street and Broadstone Place, Marylebone; Higgs & Hill, Ltd., Crown Works, South Lambeth Road, S.W.8.

Newcastle-on-Tyne. — Primary school, Cruddas Park; G. Kenyon, city architect, 18, Cloth Market.

Northfleet.—Workshops, Colyer Road, for Technical School (£122,864); Kent county architect, Springfield, Maidstone.

Northumberland.—Fire station, Alnwick (£45,000); R. Carse & Son, Ltd., builders, Prospect Road, Amble.

Nottingham.—Two blocks of maisonnettes (£71,900), Sneinton; A. A. Stuart & Sons, Ltd., Colwick.

Pewsey.—Houses (65), on eight sites; surveyor, Council Offices, Pewsey, Wilts.

St. Helens.—Departmental store, Bridge Street; Tyrers, Ltd., 8, Liverpool Road.

Seaham.—Civic centre; U.D.C. surveyor.

Sheffield.—Fire station, Mansfield Road, Intake; city architect.

Stockton-on-Tees. — Factory extension, Norton Road, for F. Hills & Sons, Ltd.; C. Tennet, Ltd., contractors, 74, Church Road.

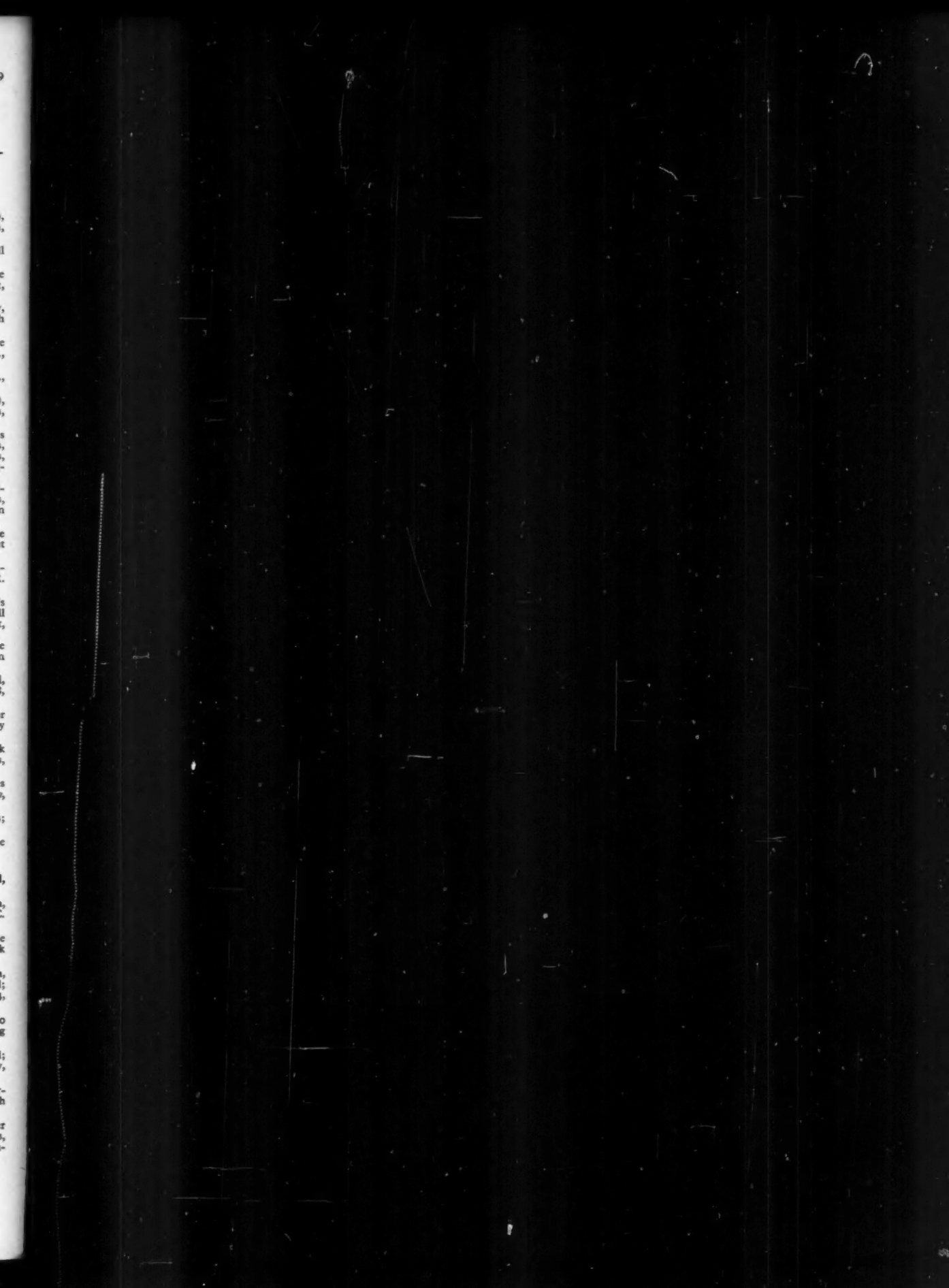
Sunderland.—Cooked meats factory, Nile Street, for J. & H. B. Ibbitson, Ltd.; Newrick & Blackbell, architects, 58, John Street.

Teddington.—Four-storey control room, A.B.C. Television Studios, Broome Road; W. S. Hattrell & Partners, architects, 14, Hanover Square, W.1.

Thornaby-on-Tees.—Development of 380 acres of land at Thornaby airfield for housing purposes; J. L. Watson, borough engineer.

Wakefield.—Offices, Denby Dale Road; Warren Neil & Co., architects, Stonebow, Lincoln.

Wallasey.—Eleven-storey flats and four-storey maisonnettes, Seacombe; borough architect, 142/148, Brighton Street.

Whitley Bay.—Self-service store and other shops near Claremont Road; Waring & Netts, architects, 36, Jesmond Road, Newcastle-on-Tyne.

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).